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PROMETHEUS, U.S.A.

ERNEST GREENWOOD

**UNIVERSITY
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Prometheus, U.S.A.

By

ERNEST GREENWOOD

Author of

"ALADDIN, U.S.A.," Etc.



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TO
L. M. G.

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AUTHOR'S FOREWORD

The Story of Prometheus

THE story of Prometheus, and its implications that the acquisition of fire established for all time the superiority of man over the lower animals, is one of the earliest myths in the story of Creation. After God and Nature had interposed and put an end to chaos, separating the earth from the sea and heaven from both, finally "establishing the fish in the sea, and birds in the air and the beasts on the land," it was decided that a nobler animal was desirable. To Prometheus and his brother Epimetheus, who belonged to the giant race known as Titans, was given the job of creating man. In addition to this Epimetheus was required to provide not only man, but all the other animals, with the faculties necessary for their existence and preservation.

He progressed fairly well, giving the different animals courage, strength, swiftness, with wings here, claws there, until he came to man. Then he discovered that he had been so prodigal with his gifts that there was nothing left for man. This, of course, created a grave emergency calling for immediate action upon the part of his brother Prometheus. Thereupon, according to the legend, Prometheus asked Minerva for help and, with her assistance, got into Heaven and lighted a torch at the chariot of the Sun. Returning to earth, he presented fire to man, and with this gift came man's

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dominion over all the earth. Fire contained the germ from which has developed our civilization as we know it today.

This story of Prometheus is the oldest and the most famous of myths created to account for the origin of fire. Its great interest lies in the fact that since the dawn of civilization fire has been conceded to be mankind's greatest possession. Certainly, without fire man would have progressed little beyond a state of savagery. It is the story of fire and the even more important story of the development and use of various types of fuel which I have endeavored to set forth in the following pages. Without some such story the record of the social, industrial, and economic progress of nations cannot be said to be complete.

E. G.

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CHAPTER I

Fire in Legend, Myth, and Religion

IN ALL ancient recitals of the beginning of things, by far the largest share in the divine government and control of the universe is given to two great powers—the sun (fire) and water. These are supposed to represent the two great forces of nature and upon their harmonious adjustment must rest the prosperity and welfare of all mankind. The history of all ancient religions carries out this thought. Fire has been worshiped, both as of itself and as the manifestation of some great spirit of which the flame is but a sign, since the mind of primitive man first turned toward some higher authority for protection.

This devotion paid to fire as a sacred element is one of the earliest forms of worship and may be found in many of its phases from the primitive ages to the present day. Fire has always been the incarnation of light as opposed to darkness and a natural object of veneration, while the domestic hearth has been the center and symbol of the home and family. The American Indians, like the natives of West Africa, paid homage to a fire spirit as an ancestor. The Polynesians and the ancient Mexicans worshiped the god of fire as akin to the divinity of the sun. The worship of Moloch in Canaan was only a form of homage to the genius presiding over fire.

Veneration for fire can be found among the early Indo-Germanic peoples; the Slavic races, including old Prussians, Lithuanians, and Russians, still preserve reminiscences of early fire worship.

Fire is the most noticeable characteristic of the ancient Persian faith. The religion of Zoroaster is sometimes called fire worship, although its descendants of the faith—the Parsees—claim that this is erroneous. However, fire played an important rôle, and the name for priest in Zoroastrian scriptures is *Athravan* which means "belonging to the fire." Zoroastrianism sprang up somewhere in the neighborhood of the Caspian Sea with its oil wells and petroleum fountains, and there still are Parsees or Ghebers who do reverence to the "eternal flame" at Baku. The modern Zoroastrians look upon fire as a symbol or manifestation of "divine power, purity, and essence."

The gospel of Zoroaster was as stern and demanding as the mountains and desert winds of Iran where it was born. Iran was a land of perpetual struggle and warfare against wind and ice and wilderness. The religion itself was one of contrasts, as Lewis Browne tells us in *This Believing World*. The universe was visualized as a great battle ground on which Good and Evil were forever struggling for mastery. According to Zoroaster, on the one side was Ahura Mazda, the Wise Spirit. His six vassals were: Good Thought, Right Law, Noble Government, Holy Character, Health, and Immortality. On the other side was Angra Mainyu, the Lie Demon. Man stood be-

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tween the two. On the one side was Good, Purity, and Light, and on the other, Evil, Filth, and Darkness. Not a bad creed even when measured by the standards of present-day Christian enlightenment.

Ahura Mazda was the God of Light and was considered as the essence of civilization; in his service there could be no compromise. Zoroaster denounced all the old gods, retaining only one "heathen rite," the veneration of fire. But Zoroaster said that fire was not a god to be worshiped as it may have been worshiped by the earliest Iranians. To him it was merely a symbol of Ahura Mazda. The fire altars which were erected by the prophet were erected only as a testimonial to the veneration in which the wise spirit, Ahura Mazda, was held. He himself may have gone about the country building fire altars and reciting hymns while he attended the holy flames, but he always made it clear that the fire ladder was not the only, or even the chief, approach to Ahura Mazda. The chief approach to him was through "daily toil." Laziness was a thing of the devil, just as we say today, "The Devil finds work for idle hands to do."

According to Zoroaster, even the "Affair," which would be the culmination of the struggle between the forces of good and evil, would call upon fire to play an important part. "Fire and death would swirl over all and there would be gnashing of teeth and dreadful wailing." But Ahura Mazda would emerge the victor, and then "all the hills and mountains would melt and pour down over the earth and all men would have to pass through the boiling lava.

To the just and righteous, however, that lava would be warm as milk; only to the wicked would it be scalding and fatal."¹

In the hands of the successors of Zoroaster, this poetic and simple religion rapidly degenerated. Ahura Mazda, who may have been simply a great ideal, became a person: some sort of super-human. His six spirits became personal angels and their number increased to ten thousand, and opposed to them were ten thousand devils. Extravagant ritual crept in. Certain things were declared to be holy, among them fire and water and earth, while, for example, a corpse was "unholy." This caused complications. The corpse could not be burned, or buried, or thrown in the water, so it had to be exposed on a high "tower of silence" where it could be devoured by the vultures. To this day the Parsees dispose of their dead in this way.

The priests of Zoroastrianism organized themselves into an hereditary order called the Magi. Their chief function was to officiate at the regular temple and household services. Masked with thick veils to keep their breaths from "polluting the holy flames," they served at the fire altars five times each day. They showed no partiality, however, for they also served at the haoma altars which Zoroaster in his day had tried to destroy.

According to Mr. Browne, "through Judaism the religion of Persia left its mark on Christianity" and "very directly also Zoroastrianism influenced the religion preached by Mohammed. . . . Only by virtue of this prevailing influence of its ideas can

¹ *This Believing World*, by Lewis Browne.

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Zoroastrianism be called a world religion today. Its nominal confessors are few, very few, in number. Only about nine thousand of their posterity are left in all the land. . . . But there is a significant colony of them in India, in all about ninety thousand Zoroastrians who dwell in and around Bombay . . . they are known there as Parsees (really, the Persians) and their culture, honesty and benevolence are bywords in all India."

Two thousand years ago, the Celts were but one of a horde of ancient peoples, but there is a fairly complete record of their rites and beliefs. Their religion was little more than a gesture. Regular festivals, which were for the most part fire festivals, were held three times a year, and once every five years these were especially elaborate. At these five-year festivals, scores of criminals, prisoners of war, and animals were placed in images of wicker and then ceremoniously burned to death. It was supposed that the greater the number of victims, the greater the fertility of the land. Fire played the greater part in all of these festivals and their purpose was the magic fertility of the land.

On the first of May, the Celts held their Festival of Beltane and bonfires of oak wood were lighted under sacred trees or poles. For hours, brands would be plucked from these fires and there would be dancing and orgiastic revelry. Everything that was done was done to suggest to the sun god and other gods what they ought to do to make things grow. Two other festivals were Lughnasad, on the first of August, and Samhain, on the last day of October. Both of these were marked by rites

similar to those of Beltane and both have persisted to this day, the one as St. John's Day and the other as Hallowe'en. The latter was the most important, for it was regarded as the day when the souls of the dead gather together with the living; and food was laid out and fires lighted on the hearths so that the shivering, hungry shades might prepare themselves against the winter months.

These great fire festivals were largely for the purpose of driving off the evil spirits and of bringing fertility to the fields. All over Europe, from time immemorial, the peasants have been accustomed to building bonfires on certain days of the year and to dance around or through them. There are the Lenten fires of Belgium, Northern France, Germany, Austria and Switzerland; the Easter fires, when it is customary in Catholic countries to extinguish all lights in the churches on Easter Eve and then kindle a new fire; the Beltane fires; the midsummer fires, which are fire festivals held generally all over Europe; the ancient fire festival of the winter solstice, which in modern Christendom has survived in the Yule log; the Need fire, a ritual of fire in seasons of distress and calamity; and, no doubt, many others. All of these ceremonies bear a certain resemblance to each other, as do the benefits the people expected to reap from them. No matter what form they took, they were supposed to promote the growth of crops and the welfare of man and beast.

There are two different explanations of these fire festivals and of the reasons why people imagined they could procure so many good things or avoid

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so many evil things by the application of fire and smoke. One may be called the solar theory and has been advanced by Wilhelm Mannhardt. This assumes the people thought that by kindling fires which mimic the source of light and heat in the sky, a needful supply of sunshine could be assured. The other, which has been called the purification theory, proceeds on the thesis that fire was supposed to burn up all harmful influences such as witches, demons, monsters and even taint or corruption in the air.

In both Greece and Rome, the fire cults of Hestia or Vesta and of Vulcan were a marked feature of religion. In ancient Rome was the "Regia" or sacred center supposed to be the abode of Vesta. It stood close to a fountain so that it would be convenient to obtain at the same spot the two great requisites, fire and water. If by any chance the sacred fire should be extinguished, all business, in fact, all activity of every kind, was instantly stopped. It was thought that the connection between heaven and earth had been broken and that it must be restored at once. At Nemi, the ritual of the worship of Diana (Vesta) was marked by the important rôle of fire. During her annual festival, on the 13th of August, the hottest season of the year, her grove "shone with a multitude of torches, whose ruddy glare was reflected in the lake; and throughout the breadth and length of Italy, the day was kept with holy rites at every domestic hearth. . . . Someone unknown dedicated a perpetually burning lamp in a little shrine at Nemi for the safety of the Emperor Claudius and his family. The terra cotta lamps which have been discovered in the grove may

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perhaps have served a like purpose for more humble persons. If so, the analogy of the custom to the Catholic practice of dedicating holy candles in churches would be obvious.¹

With the flight of the Hebrews out of Egypt under the leadership of Moses came the beginnings of a distinctive Hebrew religion and with it the foundation of all modern religions for it must not be forgotten that Jesus, the founder of Christianity, was a Jew. Moses was undoubtedly a man of very great genius and one who thoroughly understood the psychology of what was, after all, a very primitive people. He, and his followers with him, believed in the one, everliving, personal God to whom they gave the name of Yahveh—or, as we mispronounce it, Jehovah.

In the desert was a volcano known as Sinai or Horeb which had been worshiped from time immemorial by a tribe called Kenites. Either by "divine inspiration" or because of his knowledge of his people Moses understood that in addition to a fixed belief in a personal God it would be necessary to provide them with a symbol which they could understand—some thing familiar to them in their everyday lives. So he led them to the foot of this holy mountain which no doubt served well as an altar in the early days of Hebrew worship.

When the Hebrews managed to cross the Jordan and wrest from the Canaanites the "land flowing with milk and honey," Yahveh, with a volcano as a symbol, was still their chief deity. But in Canaan, the nature of Yahveh underwent a great change.

¹ *The Golden Bough*, by Sir J. G. Frazer.

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New idols supposed to have new abilities were set up. Centuries after the first settlement in Palestine, Hebrew kings were still passing their children "through the fire" to Moloch.¹

An interesting religious ceremony common to many races is known as "fire-walking." It still survives in Bulgaria, Trinidad, the Fiji Islands, Tahiti, India, the Straits Settlements, Mauritius and, it is said, in some sections of Japan. The details as well as the objects of this ceremony vary to some extent, but the essential features are the same everywhere. These consist of the passing of priests, fakirs, ("fakir" as meaning holy man and not in the sense we use the word "faker") or devotees barefoot over heated stones or hot ashes. It is usually associated with the spring festivals and is supposed to insure a bountiful harvest.

There are an infinite variety of stories, legends, myths, rituals and ceremonies involving fire in the history of religion and faith. The Arab historian, Makrizi, describes a method of stopping rain practiced by a tribe called Alqamar. They cut a branch from a tree in the desert, set it on fire, and then sprinkled it with water. The rain was supposed to vanish just as the water on the burning brand vanished. The Sulka of New Britain put hot stones or ashes out in the rain, thinking that the rain will soon cease to fall as it does not like to be burned. In New South Wales, the medicine men used to drive away the rain by throwing fire sticks in the air.

Fire has also been used as an instrumentality for the magical control of the sun. At an eclipse, the

¹ See *This Believing World*, by Lewis Browne.

Ojibways used to think the sun was being extinguished and shot fire-tipped arrows into the air, hoping to rekindle it. The Sencis of Peru also used to shoot fire arrows into the air, not so much to rekindle the sun as to destroy a savage beast supposed to devour it. At an eclipse of the moon, some tribes of the Orinoco would bury lighted brands in the earth, because they thought that if the moon were to be extinguished, all fire on earth would be extinguished except that which was hidden from her. During an eclipse of the sun, the Kamchatkans would bring out fire from their huts and pray to the sun to shine as before; this ceremony was religious rather than magical. In New Caledonia, when a wizard desires to make sunshine, he goes through an elaborate ceremony involving the use of fire, invokes his ancestors and says: "Sun, I do this that you may be burning hot, and eat up all the clouds in the sky."

The ancient Mexicans conceived the sun as the source of all vital force and named him Ipalnemo-huani, "He by whom men may live." The Mexican sacrifices to the sun were designed not so much to please and propitiate him as physically to renew his energies of heat, light and motion. The constant demand for victims to feed the solar fire was met by making war every year on neighboring tribes and bringing back troops of captives to be sacrificed on the fire altars.

In the backwood of Cambodia live two mysterious personages known as the King of Fire and the King of Water. They actually exist and maintain a correspondence with the King of Cambodia and ex-

change presents with him. The King of Fire is the more important of the two and his supernatural powers have never been questioned. He possesses a sword supposed to contain a *Yan* or spirit. If he draws it a few inches from its sheath, the sun is hidden and men and beasts fall asleep. If, however, he should draw it all the way out, then the world would come to an end. Among the annual presents sent to him by the King of Cambodia were rich stuffs to wrap around this sacred sword.

In primitive society, when the only known way of making fire is by friction with wood, the savage conceived fire to be a property stored away like sap or juice in the trees. The Senal Indians of California believe that the whole world was once a globe of fire whence that element passed up into the trees and can be extracted by rubbing two sticks together. The Maidu Indians have much the same idea. In Namoluk, one of the Caroline Islands, it is said that Olofaet, the "cunning master of the flames," gave fire to the bird *mwi* which flew from tree to tree and stored away the slumbering fire in the wood from which men can get it by friction. In the ancient Vedic hymns of India, the fire god Agni (from which we get our word "ignite") is spoken of as born in wood.

A tree which has been struck by lightning is naturally supposed by the savage to be charged with a triple portion of fire, for he has seen the flash enter the trunk with his own eyes. This perhaps explains the many superstitious beliefs concerning trees that have been struck by lightning. When the Thompson Indians of British Columbia wished to set fire

to the houses of their enemies, they shot arrows at them made from wood of a tree that had been struck or had splinters of such wood attached to them. The Wendish peasants of Saxony will not burn in their stoves wood from trees that have been struck by lightning for fear that their houses would be burned down. The Thonga of South Africa will not use such fuel nor warm themselves at a fire that has been kindled with it. On the other hand, when the lightning sets fire to a tree, the Winamwanga of Northern Rhodesia put out all the fires in the village and the head men convey the lightning-kindled fire to the chief who first prays over it and then sends the new fire to all the villages. They look upon fire kindled by lightning with reverence. The Maidu Indians of California believe that a Great Man created all the world and that lightning is the Great Man himself descending out of Heaven.¹

In the Tonga Islands, the natives say that the god of earthquakes is also the god of fire. At Mangaia, the legend is told that man went down to Hell where he discovered the secret of fire. The Maoris say, however, that he had it given to him by his old blind grandmother, Mahuika, who drew it from the nails of her hands. In Australia, there persists the legend that the "good old man" Pundyl opened the door of the sun whose light then poured on earth, and that Karakorak, his good daughter, seeing the earth to be full of serpents, went everywhere destroying them, but that before she had killed them all, her staff broke and a flame burst out

¹ See *The Golden Bough*, by Sir J. G. Frazer.

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of it. In this story we have the serpent killer as the fire bringer. The North American Indians explain the first fire by saying that it was caused by great buffaloes rushing over the plains and setting fire to the grass with sparks by the hitting of their hoofs on the rocks. The same idea is to be found in Hindu mythology.

Even today fire plays an important rôle in the ritual of the Hindu religion. Not very long ago the newspapers were filled with accounts of the approaching marriage of an American girl to a former Maharajah. In order that the marriage might take place she had to become converted to the Hindu religion. After bathing in the sacred waters of the River Godaveri she approached the Brahmin priests seated around a fire and recited the preliminary Vedic mantras. After the actual ceremony of conversion she circled the fire three times while the priests chanted verses invoking Parameshwar, the Great Lord of the universe.

CHAPTER II

The Story of Fire

IT IS a safe assumption to say that all human culture began with fire and that the uses of fire increased in direct ratio with culture itself. In fact, the great body of lore and attendant customs point clearly to stages in man's progress by which from an unused and almost unknown force fire became interwoven with his life as a prime necessity. These stages are:¹

1. The stage when man was in exactly the same state as other animals with regard to fire but with some knowledge of its manifestations. In other words, this was the period when he was familiar with the manifestations of fire in nature, such as lightning, forest fires, or volcanoes, but looked upon them as something supernatural and to be feared. He had no knowledge of either its uses or its control.

2. The stage when man in some way or another obtained fire from some natural source and found out how to preserve it for the most primitive uses.

3. The stage when man found out he could create fire at will or, as one might say, he invented a method of creating fire.

4. The stage of constantly increasing and controlling the uses of fire down to the present day.

¹ *International Encyclopedia.*



AT LAST MAN LEARNED TO GET FIRE BY RUBBING PIECES OF WOOD TOGETHER

THE STORY OF FIRE

During the first stage and before man knew anything of the use of fire, he was little better than an animal, and the distribution of men came under the same laws that regulate the movement of animals. His existence was largely individualistic and he was forced to live in those areas where the climate, natural protection from the elements and a supply of raw food made possible his existence and preservation. Presumably, he lived in caves or in the tree tops, needed no clothing, and subsisted on the raw meat of such animals as he could snare or kill with clubs or stones, and on wild vegetables, fruits, eggs, fish, and snails.

During the second stage, however, when he had found that he could obtain fire from natural sources, that he could preserve it, and had also found a few primitive uses for it, such as warming his cave or cooking the flesh of animals, man probably became sedentary and showed a disposition to congregate into groups. These groups contained the beginnings of the state. Primitive peoples kept a great community fire burning day and night. These community fires might be said to be the first public utilities. In their way, they served their groups just as the central electric light and power station or the water supply system serves its communities today. In the histories of the Egyptians, the Latins, the Greeks and the Persians, one finds accounts of these community fires in all towns and villages. The Natchez, Aztecs, Mayas and Peruvians went even further and had great "national" fires which were never allowed to become extinguished. It may be fairly said that all political and social life of these early

peoples centered around these great ever-burning fires.

The custom of community fires persisted for literally thousands of years. Whenever communities joined together for defense against a common foe or whenever chieftains secured power over other tribes by marrying into them, it was the custom to join the community fires. History tells us that Rome only became powerful when the three curiæ united their fires and formed the triumvirate which resulted in military and commercial ascendancy. Athens became renowned only when the twelve tribes of Attica, led by Theseus, brought each its branch of fire to the altar of Athene Polias, and with Delphi as its central hearth, Greece became a confederation, although some historians claim that Greece was never really united. However new fire was carried to Dolos each year, and Greece prospered, sweeping the world with its conquests. This is largely legend, largely mythology and partly history, but the moral is plain. Consolidation and cooperation resulted in greater efficiency. By the consolidation of these fires, the strength of the several tribes was united and a solid front was presented to common enemies. The "eternal lamps" in synagogues, and in the Byzantine and Catholic churches may well be a survival.

With the invention of a method of creating fire, man became free to migrate to different zones. Even before this, however, it is supposed that, having discovered the method of preserving fire, the Aryan race (the branch of the human family which came to be the ruling race of India, Persia and finally of

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Europe), using fire as a protection from wild beasts, multiplied and necessarily inhabited an ever-increasing area. Gradually, as the ice receded and dry land and a living climate followed, their outposts were pushed farther and farther north from the temperate zones and increased dependence upon fire for warmth and light and for cooking resulted.

Adventurous members of the tribe, migrating from their tribal valleys across mountain ranges and into other valleys, carried burning brands with them, stopping as frequently as might need be to kindle fresh fires and secure fresh brands with which to push ahead. In the same manner, thousands of years later, the North American Indians could be traced in their journeyings by the embers of dead or dying camp fires; as can the modern army be traced today.

Migrations of this kind, however, were always dangerous. If the fire brands should become extinguished, more often than not it meant death. With the coming of methods of kindling fire, other than from natural sources such as volcanoes, forest fires or fires kindled by lightning, came a more rapidly widening distribution of the various tribes and peoples. Now man, no matter where he might be, could kindle fire at will, and while the custom of community fires persisted, it was more for convenience or for ritual purposes than absolute necessity.

History has no record of the first cooked meal but it has been suggested that cooking became an accomplishment of the Aryan race following the accidental discovery of the use of fire for that pur-

pose by a hunter who threw his game upon some smoldering logs. As the story goes (it is purely imaginative but it will do as well as any other), this Aryan hunter was returning to his tribe just at nightfall, carrying a prehistoric rabbit which had led him far afield. Tired out, he sat down upon two logs at the edge of a blackened area which had been swept by fire, at that time a mystery and even a source of terror for the primitive man.

Throwing the rabbit on the logs a short distance from him, he leaned back to rest. An unaccustomed warmth lulled his senses and he fell asleep. Hours later he awoke. All was dark and where he had thrown the rabbit he saw what looked like the luminous eyes of an animal. Grabbing at what he thought was a thief after his game, he gave a sharp cry of pain and bounded away, thinking he had been bitten.

Seizing a heavy stick, he returned to the attack and after one or two blows he leaped back terror-stricken, for a tongue of flame showed itself between the logs. His blows had stirred up some smoldering embers and one end of his stick which he had dropped was blazing. Seeing that the flame did not move toward him and noting that the rabbit was still in the crevice between the logs, he drew near cautiously and snatched the rabbit. Nothing happened, and he sat down again with a strange pungent odor in his nostrils. This odor seemed to come from the rabbit and as he felt it the flesh seemed hot.

Timidly but hungrily, he tore off a bit of the meat and for the first time man tasted something beside

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raw food. He gorged himself on it, sitting upon the logs from between which came a gratifying warmth and a flickering but welcome light.

This hunter had discovered three things: warmth for the body, cooking of raw foods and the value of artificial light. It was his first enjoyment of heat to remove the chill from the air, his first experience with light other than natural light, and his first contact with what we would call civilized food. The discovery of artificial light and heat and of cooked food may not have happened in exactly this way, but it must have happened in some such way. It seems probable, however, that it was purely accidental.

In perhaps much the same way, the first cooking bowl was discovered. Let us suppose (again we are taking a flight into the purely imaginative), that on one of the expeditions of an Aryan tribe, the members paused for shelter under a rock, starting a huge fire at its base. At the edge of the fire, water dripped from the overhanging rock into the half of a shell of mud in which some sort of a fowl had been cooked the previous evening. One of the party being thirsty picks up the bowl and drinks the water. To his surprise, he cannot crush the bowl as he had crushed so many before. The heat had baked the clay which had come from a nearby stream and the tribe had its first bowl.

Or, if we are looking for the genesis of the first copper, let us suppose this whole tribe aroused by a startled cry by the fire tender early toward morning who, with gestures and gutturals, showed the members that the entire face of the rock was moving, and

that it was crawling on the ground, glowing red, beneath and about the edges of the fire. Snatching a few of the precious fire brands, the entire party moves from the spot in terror, building another some distance away.

In the morning, they return timidly to find that a shower has extinguished the fire and that the rock has stopped crawling. Investigation shows that the rock which had crawled will bend and break easily and some of the thinner portions are taken along. Thus, copper may have first been smelted and first used for arrow heads and blades for hatchets and for cutting instruments instead of blunt stone instruments.

With the coming of fire—that is, fire which was preserved, controlled and utilized—came the oldest business in the world, the business of housekeeping. Before primitive man knew anything more about fire than an appreciation of its natural manifestations (which were to him fearsome things) the social status of woman was about the same as that of man. She went along on the hunt and shared the hardships of the trail, when she wasn't busy producing or rearing a family. She had no special duties other than the bearing and nursing of children.

When man first began to appreciate the attributes of fire—its uses for protection, for cooking, and for warmth—came the desire for its preservation and then came the first cry of "woman's place is in the home." It is not difficult to picture a member of an Aryan tribe—probably a Mongolian or an Altai—saying to his wife: "Now listen to me. I've got to get out and tend to business and it is up to you

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to stick around the house and keep it in some degree of comfort. You know perfectly well what will happen if you let that fire go out. I've piled up a lot of firewood just outside the cave so keep the house nice and warm, and if I am lucky we will have some roast deer meat for dinner. If not, you can warm over that stewed rabbit we had last night."

And so women had to add to their duties of bearing and rearing children the duty of tending the fire and seeing that it was never extinguished. Perhaps even in those days cooking became the pride of women. They soon learned to make scant clothing and to keep their children warm and dry. They probably began utilizing the skins of animals which had been killed for meat, and while tending the sacred family fires, first turned their attention to dressmaking and millinery. No doubt, having to listen to the complaints of the men folks about the amount of fuel consumed during the day, they soon learned to conserve it and thus established the habit of thriftiness which, as we all know, has been the heritage of the sex ever since.

Seriously speaking, upon woman's fidelity to her trust depended the welfare and even the lives of her family and her tribe. Disaster often followed in the wake of destruction of the fire. New fire could only be had from friendly neighbors, or by theft, or by fighting for it. Hers was the real duty of preserving the home by guarding the hearth—which since time immemorial has been the symbol of the family and the home. Small wonder it is that when man added priests to his social order and for these

same priests temples in which eternal fires, the symbol of some all-creative and governing force, must be kept burning, women were intrusted with the duty of tending those fires. It was the Vestal Virgins of the Regia, Rome's sacred center, whose duty it was to keep the fire burning before the altar of the goddess. Thus, woman took her place in early religion and religious rites.

The advent of housekeeping was not altogether an unmixed blessing. It will be remembered that the last chapter described how ancient peoples, noting that the force of the sun grows weaker after the noon hour, were of the belief that the force of fire grew weaker likewise and that it must be renewed, and thus sprang up the spring festivals. Through evolution these spring festivals became periods of general rejoicing and—general house cleaning. Caves were cleaned out, shelters were repaired, new clothing was worn, and the climax came when the fire was rekindled. And so, as far back as legend and history are available, all races have celebrated by cleaning house in the spring; and civilized as we are, we, today, go through this same agony which is no longer considered as a festival but as one of the burdens placed upon long-suffering mankind by the keeper of the hearth.

CHAPTER III

Implications of Fire

MANY students of history urge that the rise and fall of nations has always paralleled the rise and decline of their transportation facilities or the rise and decline of their control over trade routes, which is just another way of saying the same thing. One railroad man recently said that in his opinion Europe would not be faced with its present-day problems if Rome, when at the height of its power, had possessed a couple of locomotives and facilities for making rails and laying tracks. He also claimed that the United States would not be the homogeneous nation it is today if the nation had not had its beginning and growth paralleling the beginning and growth of modern transportation.

The agriculturist, who considers his industry the basis of all civilized life, has but one question to ask when begging for some sort of farm relief legislation, and this is: "What would you do without the farmer?" He, too, is right. If the farmer is as bad off as we are led to believe he is, then it is quite within the range of possibilities that we will shortly become a nation of abandoned farms. This would no doubt solve the problem of farm relief for the politicians, but would create another sort of much more serious problem—one which more than one

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European nation has had to face during the past fifteen years.

The textile man, who necessarily thinks of civilization in terms of clothes, is quite sure that the step from barbarism to civilization was taken when man—perhaps I should say woman—began to spin and acquire something besides the skins of animals to cover his nakedness. The builder begins his history of civilization with the modern home or office building, while the plumbing contractor will tell you that no civilized person could exist without modern plumbing. The publicity man for a large soap manufacturer claims that man did not become civilized until he began to use soap, and many of us will agree that soap is a necessary attribute of civilization.

Any official of a light and power company will tell you that the genuine up-to-date civilization began in 1882, when the first central generating station was put into operation in Pearl Street, New York. The oil man is just as sure that it began when Colonel Drake brought in his first drilled oil well in 1859. The telephone and telegraph engineer will say it began when communication by means of an electric current over a wire was established, while the radio man is sure that this form of communication is antiquated. In fact, every industrial or professional group, whether it be in steel, automotive, transportation, light, power, communications, clothing, housing or any other enterprise, dates the beginning of real civilization with the beginning of the work in which it is engaged.

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As a matter of fact, however, without fire, it is doubtful if man would have ever reached a state of intelligence where any one of these things would have come within the limit of his mentality. The story of Prometheus may be only a Greek myth but its moral is unmistakable—without fire man would have remained but slightly above the level of the animals and subject to all of the limitations of animal life. And even with a knowledge of fire, and how to kindle and preserve it, he would have been but little better off without the development of modern fuels such as petroleum, gas and coal. It is fire, plus the modern fuel and modern methods of utilizing fuel, that has raised our standards of living so high, and a constant improvement in the standard of living is only another way of defining the progress of civilization.

Before man ceased to regard fire as some fearsome manifestation of the supernatural and learned how to control and utilize it, he was confined to the more temperate and tropical zones. It is doubtful if he would have migrated to the colder climates, and a large portion of the world would therefore have been closed to him as a habitation. He would still be living in trees or caves, or, at best, in rude structures made of stones and mud or the boughs of trees. His food would still consist of raw meat, wild fruits and berries, and his clothing, if he wore any, the skins of animals. He would still be without artificial light of any kind, and without protection other than that supplied by his own brawn and such rude weapons as a prehistoric man might be able to devise.

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It is all very well for our transportation man to say that modern civilization began with transportation; but while the wheel might have been invented by some one of our savage ancestors its use would have been limited, at best, to some form of rude cart with wooden axles. Transportation would have been confined to these vehicles drawn, perhaps, by some tamed animal, to travel on the backs of animals and by water. Without fire, the use of wood, oil, or coal as fuel, steam, or electricity (other than its manifestation in lightning), would never have come within man's experience.

Without any of these things it is doubtful if man would have ever known the meaning of any agriculture worthy of the name. Even though he might have learned a little of the art of cultivation it would have been of little use to him. Without fire he must eat his vegetables, grain or fruit raw, and he might just as well be satisfied with such edibles as grow wild. It is modern agricultural machinery and modern methods of utilizing the products of agriculture, all of which depend upon fire, that have gradually brought about a social condition which makes agriculture the basic industry of present-day civilization. Without fire we would have no farm problem, no farm blocs and no parliaments to be distressed by them, no McNary-Haugen Bill and no necessity for vitriolic messages vetoing it. In some respects life would be greatly simplified by the absence of fire.

It is so evident that without fire there could be no such thing as modern industry or, in fact, indus-

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try of any kind, that it is scarcely worth while mentioning it. Construction would be confined to rude huts of stone and wood or mud; and even though man might accomplish something which would resemble in a remote way the modern home, it would be of no value except in the temperate or tropical areas, for it could not be heated and would serve only as shelter from the elements and from animals. Even the Eskimo in his igloo has fire. Man might have devised some rude method of spinning and weaving, but this would be his closest approach to the textile industry of today. Food, clothing and shelter would still remain that of the most primitive days, while transportation and communication would still be accomplished only by the methods of the wilderness.

But while we may safely say that civilization began with the utilization of fire, this fire cannot receive the entire credit for the progress of civilization. Much of the credit must go to the development of methods of utilizing what we may call modern fuels: oil, gas and coal. Until comparatively recent times wood was the only fuel in general use, although the inflammable qualities of petroleum were known in ancient times. The first record we have of the use of coal in England was in the year 852, although there is some evidence that it was used by the Britons previous to the Roman invasion. It was also mined in China before the Christian Era. While the Chinese are supposed to have piped natural gas through bamboo pipes and used it for lighting over 2,000 years ago, it was not until 1792 that

the practicability of manufactured gas for lighting was demonstrated when William Murdock succeeded in lighting his home with it. People in the United States were laughing at the idea of using the "black stones" (coal) for fuel in 1800, while the first use of manufactured gas for street lighting was in Baltimore in 1816. Natural gas power was used by the Jesuits in New York. Petroleum received very little consideration as a fuel until Colonel Drake demonstrated the practicability of drilling for it in 1859. Yet, here again, we are told the Chinese were drilling thousands of years ago and that there has been but little change in the method except that brought about by the use of the steam engine.

Even with fire and without any other fuel than wood, there are a host of things which we would not have nor have even dreamed of, though they are commonplace today. We think of water power as a method of obtaining light and heat and power without the use of fuel, but if it had not been for fire and the modern methods of utilizing fuel we would never have had the machinery necessary to generate power from the flow of water. Transportation and industry would be crude affairs at best if both had to depend on wood for fuel, while the heating of homes and offices would still be in the stage of the open fireplace. Without coal or oil there would be no manufactured gas, and cooking would be done with the wood stove or over the open fireplace in the kitchen. Applied electricity would still be in the experimental stage.

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In subsequent chapters we will learn something of the development of the use of these fuels and what these developments have meant to us in the United States.

CHAPTER IV

The Story of Wood

IT HAS been so long since the great mass of the American people have thought of wood as a fuel for cooking and heating that it might almost seem that it has no place in this book. It must not be forgotten, however, that wood was the first fuel to be generally used by man and that his first knowledge of methods of handling fire came from its chance ignition although petroleum was burned in Mesopotamia since the dawn of history. Nor must it be forgotten that for centuries, in fact for thousands of years, it not only was the principal fuel but was practically the only one. The community fires of primitive man which were, as we have seen, the first public utilities and contained the germ of a state, were all fed with wood.

Until the coming of coal and oil and the development of modern methods for utilizing these fuels, industry was solely dependent on wood as a source of heat for manufacturing and even for transportation other than that furnished by horses or by boats and rafts. The first steam engines were fired with wood as were the locomotives of the pioneer railroad days. Looking at one of the great transcontinental trains of today, one wonders how far it would get if the giant locomotive had to be fired with wood. Yet, when the first locomotives were

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placed in service drawing their little wagonlike cars at a speed of fifteen or eighteen miles an hour, it was thought that the last word in rapid transportation had been spoken.

Even in the days of our grandfathers, wood was the principal fuel for cooking and heating, and some of us can still remember that the wood pile was a source of great unhappiness when there were so many things one would rather do. Today, wood is still used in remote rural sections, although the oil cooking range and the portable oil heater are rapidly supplanting it in every corner of the United States. In the cities, we still cling to the sentiment of the open wood fire and most of our finer modern residences have one or more fireplaces; they are even built in some of the larger apartments. There is something about an open wood fire which can never be given by any other form of artificial heat.

Someone has said that this is a nation built of wood and that it will continue to be built of wood for the next hundred years. This is only natural, as no country in the world has ever had in the past the great forests and the hundreds of varieties of trees that existed on the North American continent in the fifteenth century. There are standing today in California great redwood trees that were middle-aged and perhaps patriarchal when Christ was born, two thousand years ago. They are perhaps the oldest living things on the face of the earth. In the Eastern states, there are white oaks still standing that were acorns when William the Conqueror took England, 500 years before Columbus started on the voyage which was to make him immortal. While

Europe has only about 25 important timber trees, few of which reach any unusual size or attain great age, North America has at least 525 different kinds of native trees, many of them famed throughout the world for their huge bulk and antiquity.

When the first settlers landed on the Atlantic Coast, no less than 900 million acres of the United States were rich timber lands, far richer than any of which the white man had ever dreamed. But to find room for themselves and their families, these early colonists had to become our first lumbermen. The forests were both friends and foes, for though they supplied fuel for cooking and warmth as well as wood for shelter, they also blocked progress. Thousands and thousands of acres of the finest timber were destroyed in order to make room for additional farms and buildings. Land must be had to sow and cultivate the first crops, and their early homes were simply log cabins surrounded by a little patch of corn.

Mr. Joseph Illick, writing in *A Popular History of American Invention*, gives a fascinating story of these early colonial days. He says:

“During this initial development of American civilization, the pioneers began to realize the great wealth and worth of the forests. Not only were rough logs used for homes, school houses and churches, but for strongholds, forts and stockades to shelter the brave frontiersman and his family from the attacks of the Indians. With the establishment of trading posts, more lumber was needed for construc-

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tion, and as water transportation was developed, there began a commercial demand for timber.

“That demand grew in leaps and bounds. Thousands of colonists came, cities and settlements had to be built. Ships, fashioned of native oak and pine, carried the riches of the New World to the Old. As industry increased, factories were erected. Yet more wood was required for the making of furniture and wooden implements. Wider and wider grew the inroads into the thick forests. Trees were cut down and worked into matches; they were ground to a pulp to make the paper on which news is printed; they were required for turpentine and resin; they were put into the still so we might have alcohol for varnish and fuel. The childrens’ toys, the farmer’s scythe and plough, a thousand necessities added to the call for lumber. Vast quantities were shipped to Europe, where there was not much timber of the quality found in America; and as the demand upon our resources became greater and greater, the means and methods for acquiring it had to be increased.

“Remarkable as has been the enlarging of the facilities for the employment and usages of wood in trade, the work of felling trees and making the trunks ready for the factory and sawmill is done almost entirely by the axe and saw, implements which in form are little removed from those used by our forefathers. Who made the first axe? This is very much

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like asking who ate the first oyster. Long before recorded history, man swung an axe. At first it was simply a pounding instrument or a weapon, made of flint and rock. Some ingenious inventor of the Stone Age probably bored a hole in this tool and drove in a handle. It gave him a lever, adding force to his blow when he broke up dead branches that had fallen from trees during a storm. Some early tribes, and among them the North American Indians, chipped a groove about the stone head and bound a piece of pliable wood around it, holding it down in place with withes and gum. Then one end of the head was chipped down to a fairly thin edge, and the axe,—as specimens from the oldest dwellings and caves show—developed into a cutting tool. To this day, most axes are made so that they may be used both for chopping and pounding."

It is easy to understand why, until possibly fifty years ago, the supply of wood in the United States seemed to be inexhaustible. It must have seemed inconceivable that the original 900 million acres of standing timber could ever be exhausted before a new crop had reached maturity—regardless of the demands for fuel, construction and the thousand and one articles made of wood.

According to the census of manufactures taken in 1925, lumber and its manufactures ranked 8th among the 16 industrial groups in respect to value of products, which reached an aggregate value of \$3,689,000,000. The total value of output was

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about 1.5 per cent more than in 1923 and was very much larger than in any other census year. The National Lumber Manufacturers Association estimates the production of lumber in the United States in 1927 at 35 billion board feet, a decrease of $2\frac{1}{2}$ billion board feet from the estimated production in 1926. This is the largest lumber producing country supplying over one half of the world's demands. Other important lumber producing countries are Canada, Finland, Sweden, Russia, Japan, Poland, Norway, Germany, Rumania, Czechoslovakia, Yugoslavia, and Brazil.

Building construction in the United States uses about 60 per cent of the manufactured lumber. Railways account for the consumption of about 11 per cent, their purchases being largely ties, timber and planking. About one fifth of the total lumber cut is consumed by various manufacturing industries, other than those reworking lumber into building materials, the most important of which is the box and crate industry. The balance of the production, which it is estimated amounted to about 9 per cent in 1927, is exported.

Many other products in addition to lumber are derived from our forests. According to the Department of Agriculture about 9,500,000,000 cubic feet of wood are removed annually from the forests for fuel which is about 13 per cent more than goes into dwellings and other buildings. So we see that while we may think of the use of wood for fuel as passing it is still playing an important rôle in that capacity. Pulpwood and naval stores are also very important forest products.

Among important wood products are cooperage, ply woods and veneers. According to the 1926 census the production of lathes amounts to 3,083,000,000 pieces and shingle output totaled 6,008,000,000 pieces. Railroads purchased 111,000,000 ties in 1925 as compared with 136,000,000 in 1923. Agriculture is also dependent on lumber as the farms consume about 40 per cent of the entire output.

In 1925, as a part of Mr. Hoover's elimination of waste program, The National Committee on Wood Utilization was established as an impartial, cooperative undertaking between Industry and the Government. The Committee consists largely of representatives of trade and professional associations. Its aim is to effect a wiser and more efficient use of wood and forest products as a means of advancing commercial reforestation. The importance of this work is indicated by a survey of non-utilized woods in the State of Virginia which shows an annual supply of 20,000 car-loads of this wood. Similar surveys are being conducted in other states.

Many other construction materials are now rapidly supplanting wood, especially for large buildings. Steel and concrete are the order of the day, while metal is being used more and more for office furniture and many other articles heretofore made exclusively of wood. There will always be a large number of people, however, who prefer frame houses to those made of brick, stone or other materials; and it will be more than one generation before we can write finis after the history of wood as a building material as we are now writing it after the history of

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wood as a fuel. We should also remember that wood as fuel made possible those industries which were the forerunners of the present-day industries supplying us with modern building materials.

But though we may eventually dismiss wood as fuel, we cannot dismiss the part which it must have played at the beginning of the world in preparing for us our great stores of fuel oil and coal. In the next chapter, we will see how millions and millions of years ago dead and decaying vegetation sank beneath the waters of the swamps and how in Nature's coke oven changed into what we know as coal. Much of this vegetation was of course some form of wood. Many authorities think that petroleum was formed in some such manner, that its origin was organic rather than inorganic. Sir Boverton Redwood called attention to the fact that the relation between petroleum and oils obtained by distillation from peat, lignite and coal, led, at an early date, to a belief that petroleum was produced from one or all of these materials. While this theory was soon abandoned in its original form, a few later writers have considered that terrestrial vegetation has in some cases undergone what is called a special mineralization, being changed to liquid and gaseous hydro-carbons in place of the usual solid lignites and coal. By the distillation of wood with superheated steam, a distillate smelling like the oil of Alsace was obtained. Sir Boverton had in his own possession before he died samples of soft woody fiber containing petroleum, while Griffith, finding free phenol in pine cones, has suggested that

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petroleum was derived from their decomposition. In any event, there is much evidence that our two great modern fuels can claim some form of wood as an ancestor even though many authorities claim there was no true wood in the carboniferous period.

CHAPTER V

The Story of Coal

WHEN Theophrastus, the Greek orator and friend of Aristotle, wrote a description of coal in 300 B.C., in which he said that this black stony substance "burns like wooden coals," he could not have realized that he was writing the introduction to the industrial history of the world. If he might have had a sudden vision of "deep mines with their grimy toilers, innumerable smoking chimneys, the steam engine, the blast furnace swallowing 400 tons of coal a day, iron rails that span continents, floating palaces of steel, big guns and armor plate, huge skyscrapers, and an age of electricity—all of which would be impossible without these same black rocks dug from the depths of the earth"¹ he would have been quite as startled as primitive man when he first saw a volcano in eruption or lightning setting fire to a tree.

"Coal is crystallized buried sunshine," says Mr. Floyd L. Darrow. "Together with its twin brother, iron, it has spelled dominion; first over the material elements of nature, then over industry and the military and political course of empire. Along its black trail we trace the ever-expanding growth of the world's industrial life. Without coal, nations wither and decay. Coal and yet more coal is the never-

¹ "Buried Sunshine" by Floyd L. Darrow, writing in *A Popular History of American Invention*.

ceasing cry of every workshop in the world." This has been true until comparatively recent times. Now fuel oil is rapidly supplanting coal for many purposes, as we will presently see.

Millions and millions of years ago, long before primitive man had appeared, the earth passed through what the scientists call the "carboniferous period." The atmosphere was dense and hot and humid, and all along the borders of seas and inland lakes were vast swamps in which grew the most luxuriant vegetation. From time to time, the waters engulfed these swamps. Then the dead and decaying vegetation became gradually covered with layers of mud and sand and at first peat bogs were formed, such as will be found today along our Atlantic Coast and in Ireland. Gradually the layers of sediment grew thicker and the tremendous pressure, together with the heat developed by it, squeezed out all gaseous matter and changed the vegetation into what we know as coal. "Here," says Mr. Darrow, "is Nature's coke-oven." It has produced every variety of coal from peat and lignite to bituminous and anthracite, the particular kind depending upon the amount of heat and pressure to which the vegetation was subjected. The anthracite coal contains the largest percentage of carbon and the least oily or gaseous matter. It is the hardest of the coals and burns slowly, with the least smoke.

There is every reason to suppose that some primitive man, building his fire on an outcropping ledge of black rock, discovered that this particular rock would burn, and thereby discovered the use of coal. It was in exactly this way that a hunter, Nicholas



IN ENGLAND THE HEARTH FIRE BECAME THE CENTER OF SOCIAL LIFE

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Allen, found coal near Pottsville, Pennsylvania, in about 1790. He had been hunting all day and at night built his fire under a ledge of black rocks. Sometime during the night he was awakened by a strong light shining in his eyes and discovered that "the mountain was on fire." He had built his fire on an outcropping of coal and this led to the discovery of one of the richest coal regions of the state. Why should not man, in any of his states after the discovery of the use of fire, have done the same thing thousands and thousands of years before?

Coal was mined in China long before the Christian Era and there is much evidence that it was used by the Britons previous to the Roman invasion in 54 B.C. The first known record of its use in England, however, is in the year 852 when the Abbey of Petersboro gave a receipt for "twelve cart loads of coals." The Bishop of Durham gives an account of mining operations in 1180 and the first shipment of coal to London occurred in 1240. Marco Polo, the famous Italian traveler, mentions its use in Cathay in 1275. In 1612, it was first used in a blast furnace for the production of iron.

Coal was first discovered in the United States in 1673 by the Jesuit missionaries Joliet and Marquette. In the year 1689, Father Hennipin published a map showing a "cole mine" along the Illinois River. In 1776, the Indians complained to the governor of Pennsylvania that white settlers were robbing their mines, showing that they were acquainted with the coal beds and the use of coal for fuel. The oldest coal mines in America are the bitum-

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inous mines near Richmond, Virginia. They were discovered in 1702, but the mines were not opened until about 1750, and during the Revolutionary War coal was in common use throughout this region. In 1760, anthracite was first discovered in Rhode Island and two years later settlers from Connecticut discovered anthracite in the Wyoming Valley, Pennsylvania. The beds of the Schuylkill were discovered in 1770 but were not developed until 1834.

Mr. Darrow tells an interesting story in connection with the Lehigh Valley region. Philip Gunter, a poor man who supported his family by hunting and trapping, was returning home after an unsuccessful day and came down by the side of Bear Mountain. His foot struck a shiny black stone which he picked up and decided was coal, the new fuel people were discussing. He investigated and found all about him the black rocks in abundance. He reported his find to Jacob Weiss at Fort Allen and a quarry was soon opened. In the following year, the Lehigh Coal Mining Company was organized.

“Gradually the coal industry grew. In 1795, a blacksmith named Whetstone began to mine and use coal in the Schuylkill region. In 1800, it was being shipped from Pottsville to Philadelphia. But its use for domestic purposes had not yet been demonstrated. The burning of coal and its substitution for wood was still in the experimental stage. People were laughed at for buying the black stones. Criticism seemed justified when, in 1803, the Lehigh Coal Mine Company shipped two boatloads to Phila-

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delphia, and the 'stuff,' refusing to burn, had to be used in place of gravel on the sidewalks.

"But its importance as a domestic fuel could not long be delayed. In this same year, in Philadelphia, Oliver Evans first burned coal in a grate, and Frederick Groff, also a citizen of the Quaker City, repeated the experiment shortly after. Another boatload sent to Philadelphia, in 1806, was rejected. Even as late as 1812, Colonel George Shoemaker narrowly escaped arrest as an imposter when he offered nine wagonloads of coal for sale in Philadelphia. (The next morning, however, his coal was found to be all that he had represented although it could not be burned like the bituminous variety.) He succeeded in selling only two of them, then gave the other seven away. In 1808, Judge Jesse Fell gave a public demonstration in which he burned coal in the grate in the barroom of his hotel at Wilkesbarre. This was regarded as a great event, and people came from far and near to witness the strange spectacle of rocks superseding wood in the fireplace, and burning merrily.

"One of the wagonloads of coal sold by Colonel Shoemaker had been purchased by White and Hazard, wire manufacturers located at Schuylkill Falls. After spending all night in unsuccessful efforts to make the stuff burn, they gave it up in despair. Fortunately, they left the furnace door shut, and when a workman returned some time later to get his coat, he found a red hot fire. People did not under-

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stand, at first, that a coal fire should be left alone and not poked.

"In 1805-6, John and Abijah Smith of Derby, Connecticut, settled at Plymouth, Pennsylvania, and immediately formed the coal firm of Abijah Smith and Company, the first in America to devote itself exclusively to the mining and marketing of coal. In 1807, they shipped fifty-five tons to Columbia, Pennsylvania, and from then on, 400 to 500 tons annually to New York and Baltimore, for which supply they received from \$10 to \$12 a ton. When one considers the purchasing power of money then, coal was certainly an expensive luxury. The Smith Brothers shipped their coal in crude boats called 'arks.' They were ninety feet long, sixteen feet wide and four feet deep. Each ark carried sixty tons of coal and was manned by a crew of four men. Seven days were required to reach tide water on the Susquehanna.

"These industrious brothers realized that if they were to succeed in marketing their product they must teach the people how to use it. They therefore devised a special kind of grate, and with infinite patience did the pioneer work of introducing coal as a domestic fuel. From their records, we find that New York began to use coal in 1812 and in that year consumed 200 tons. The first anthracite coal in New York was that of Price and Waterbury, who sold it at the rate of \$25 for 3,000 pounds. [This was \$16.33 a 2,000-pound ton which is about

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the dollar price of anthracite in Westchester County, N. Y., today. Considering the value of a dollar in commodities a hundred years ago, this means that coal in those days cost from \$35 to \$50 a ton.]

"The Lehigh Coal and Navigation Company, the oldest coal company in America still in existence, was organized in 1818 and began business in 1820, which year they shipped 365 tons of anthracite to Philadelphia. This Company was a tremendous factor in developing the coal fields of the East. Another of the old coal companies is the Delaware and Hudson Canal Company, which was organized in 1823 and began to make coal shipments in 1828.

"The first use of anthracite in the smelting of iron occurred at the nail and wire mill of White and Hazard, at Schuylkill Falls, in 1812. To generate steam power, it was first used in this country in Thompson's rolling mill at Phoenixville, Pennsylvania, in 1825. Coal had been thus used in England for nearly a century. First in Savery's, then in Newcomen's, and finally in Watt's steam engines, coal was the source of power for pumping water from the mines. In America, with the coming of steamboat and locomotive, coal rapidly came into use as the most important source of energy. In the old 'Pioneer Furnace,' at Pottsville, Pennsylvania, built by William Lyman of Boston, anthracite was first used in the smelting of iron ore. Publicly recognizing the fact that Lyman, with the use of anthracite, had produced pig iron contin-

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uously for 100 days, Nicholas Biddle and a number of other far-seeing public-spirited men, in 1839 awarded him a prize of \$5,000. The first successful blast was blown in October of that year."

And so we see, in spite of the fact that Theophrastus first wrote a report on this "black stony substance that kindles and burns like wooden coals," and also in spite of the fact that its possibilities as fuel have been known throughout these countless generations, its efficient utilization and its service as the basis of present-day industry is comparatively new—only a matter of a hundred years or so. Only a little more than a hundred years ago, people were laughing at those who bought these "black stones," just as only a little more than forty-five years ago people were laughing at Thomas A. Edison; a little more than twenty-five years ago were laughing at the automobile; a little more than fifteen years ago were laughing at the radio; and less than ten years ago were sneering at the oil burner in furnaces for heating homes. Regardless of past history, it seems to be human nature to ridicule anything which is new, startling or little understood. And yet what would be the position of the United States among the nations of the world today if there had been no coal in the United States?

In spite of this fact, we are already inclined to sneer at raw coal as a direct fuel and consider it *passé*. It is true that oil for fuel both for the purposes of heating and for use in the production of power is rapidly taking its place in many parts of

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the country. It is also true that water power is being utilized more and more in place of power generated by the use of steam made from the burning of coal although it can never supply the power requirements of American industry. Nevertheless, to coal goes the credit for building the very foundations of American industry and it will be a long, long time before it is entirely replaced by oil, water power, or some synthetic fuel of the future.

Without coal, our transportation system, the greatest in the world, would still be in its early stages of development. Coal was an imperative necessity in the smelting of iron so necessary for the rails and the equipment of our railroads. Coal was the only kind of fuel that was available in the early days; how far would our railroads have traveled if they had had to depend on wood? Coal was an absolute necessity to run the industries which eventually produced the machinery from which our water-power generating plants are built. Until very recently, coal has been the only efficient fuel for use in the "central fire" in the cellar by means of which we have been able to heat our houses all over, from cellar to garret. Coal has produced the steel as well as the cement for our modern structures, whether office buildings or factories; almost the sum total of modern construction in America is nothing more or less than a monument to coal.

CHAPTER VI

The "Wild Spirit" of Helmont

EARLY in the seventeenth century—about 1609, according to such records as are available—one John Baptist van Helmont, a Dutch chemist, discovered that certain fuels yielded what he called "a wild spirit." Until this time, Helmont had devoted his researches to alchemy and was among the last of a long line of philosophers who sought for some method of making gold out of baser metals. Having abandoned these efforts, he turned to chemistry and accidentally discovered artificial gas (what we called manufactured gas to distinguish it from natural gas), which he claimed had been up to that time unknown, was not susceptible of being confined to vessels, nor capable of being produced in a visible body.

A few years after Helmont's discoveries, natural gas was discovered in various places in England. The earliest description of these discoveries seems to have been written by Thomas Shirley in 1667. He speaks of what was considered to be a spring "where the water did burn like oyle and did boyle and heave like water into a pot." On investigation he found this to arise "from a strong breath, as it were, a wind which ignited on the approach of a candle" and "did burn bright and vigorous." Natural gas was also discovered in other parts of the

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world and in those days it was supposed to be the work of some supernatural agency. In some instances where it became ignited, it was worshiped by the fire-worshippers, as in the case of the sacred fires of Baku.

In Greece, one summer afternoon many centuries ago, a shepherd noticed that his goats, when they came to a certain spot, wandered about in an unusual fashion. He investigated and found that he too became curiously affected from something that came out of the ground. Frightened, he ran and told his neighbors who also had the same experience, becoming light-headed and talkative, although their conversation was disconnected and difficult to understand. They agreed that they were in the presence of some supernatural manifestation and that a god must live somewhere in the vicinity. They appointed a priestess and built a temple where people might go for advice. Thus the Oracle of Delphi became famous.

It was many centuries before gas, such as was found at Delphi, was understood or used. In some countries it was utilized during periods of more advanced civilization but in others it mystified and frightened the people. Long before natural gas was discovered in Europe, however, the Chinese are said to have made use of it. They piped it through bamboo tubes and used it for lighting, but it never became popular.

It remained for Dr. John Clayton, a Yorkshire minister and something of a scientist, to bring gas within the realm of practical things by a series of experiments which he conducted from 1660 to 1670.

He found at Wigan what he described as "shelly coal." Heating this coal in a closed vessel, he found that a "spirit which issued out caught fire at the flame of a candle." Dr. Clayton delighted in amusing his friends with demonstrations of the use of this gas. He would collect the gas in bladders and by pricking holes in them with a pin would light the colorless gas with a candle.¹

Because of the superstitions which surrounded it, progress in the development of gas was slow. Dips, floats and then tallow candles were still the common method of illumination until late in the eighteenth century when William Murdock, by distilling coal in an iron retort and conducting the gas through tinned and copper tubes, succeeded in lighting his home at Redruth in Cornwall in 1792. In 1798 he built an apparatus on a large scale and lighted the factory of Boulton, Watt and Company, builders of steam engines, with gas. In April, 1802, on the occasion of the celebration of the peace of Amiens—the signing of a treaty by Great Britain with France, Spain and Holland—a public display of the new light was made. Matthews, one of the earliest writers on gas lighting, describes this spectacle as follows:

"The illumination of Soho works on this occasion was one of extraordinary splendor. The whole front of that extensive range of buildings was ornamented with a great variety of devices that admirably displayed many of the various forms of which gas light is susceptible.

¹ *The Story of Gas*, Committee on Education, American Gas Association.

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This luminous spectacle was as novel as it was astonishing and Birmingham poured forth its numerous population to gaze at and to admire this wonderful display of the combined effects of science and art. The writer was one of those who had the gratification of witnessing this first splendid public exhibition of gas illumination and retains a vivid recollection of the admiration it produced."

What would Matthews say if he could return, 125 years later, and walk down the main street of any city or town in the United States, any evening after dark?

In much the same way the *London Times*, on July 2nd, 1804, printed the following description of an exhibition of gas lighting in the Lyceum Theatre, London:

"Sir Joseph Banks, ever indefatigable in examining and promoting useful discoveries, went last Thursday evening, for the second time, with a large part of his noble and scientific friends to the Lyceum to witness the incredible effects of smoke; the whole theatre was lighted with the same, in a novel and pleasing manner; the arch of lights above the stage had a very striking effect, and from the English grate on the stage, (which may be fixed in every room) issued a very brilliant and fanciful light. The products of tar, ammonia and coke were produced and much approved of. Several experiments were made during the course of the lecture, such as boiling a tea kettle and melting

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ores in a few minutes on a table. It was also proved that a brilliant flame adapted to light-houses could be formed, which no rain or storm could extinguish. The noble and learned visitors, after a minute examination of the apparatus, stoves and products, expressed the liveliest satisfaction."

What would the "learned and noble visitors" have to say if they could visit a modern theater today?

This exhibition was given by Albert Winsor, a German, who obtained the first English patents for gas-making purposes. He had proposed the organization of a company for "enlightening the inhabitants of London," but he stated his claims so extravagantly that much opposition was aroused to his scheme. As the Education Committee of the American Gas Association says, "He was confronted with a Herculean task in fighting against old-established customs and prejudices. All of his predictions regarding the utilization of gas have proven true during the last fifty years, although for many decades after he established the first gas company, gas was used only for lighting purposes. Winsor, more than one hundred years ago, foresaw some of its present-day uses."

Winsor was a great advertiser. He not only exploited the wonders of gas in prose but also in poetry, as:

Must Britons be condemned
forever to wallow
In filthy soot, noxious smoke,
train oil, and tallow,

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And their poisonous fumes
forever to swallow?
For with sparky soots, snuffs,
and vapors, men have constant strife;
Those who are not burned to death,
are smothered during life.

His claims excited great opposition and he was the object of much ridicule. Sir Walter Scott wrote a friend saying: "There is a madman proposing to light London with—what do you think? Why, with smoke." Napoleon, when he heard of the plan, dismissed the idea as "*une grande folie*." Actors in music halls poked fun at him while humorous writers continuously burlesqued him. Despite this opposition and ridicule, he succeeded in getting the necessary financial backing, and the first public street lighting with gas took place in Pall Mall, London, on January 28th, 1807. In April, 1812, Parliament granted a charter to his company, "The London and Westminster Gas Light & Coke Company" and thus, 116 years ago, the first gas company in the world was born. Baltimore was the first city in the United States to light its streets with gas in 1816, and in 1820 Paris was lighted with gas. Today, the industry in the United States represents an investment of more than four billion dollars.

Other cities soon followed the lead of Baltimore, although in 1830, after gas lighting was used successfully in Baltimore, Boston, and New York, Philadelphia still fought against it and prominent citizens succeeded in blocking it until 1836. In New England, the proposal to light with gas aroused a storm of protest. Some of the arguments against it,

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printed in a New England paper which represented the best and most serious thought of the times, were:¹

1. A theological objection. Artificial illumination is an attempt to interfere with the divine plan of the world which had pre-ordained that it should be dark during the nighttime.
2. A medical objection. Emanations of illuminating gas are injurious. Lighted street will incline people to remain late out of doors, thus leading to increase of ailments by colds.
3. A moral objection. The fear of darkness will vanish, and drunkenness and depravity increase.
4. Police objection. Horses will be frightened and thieves emboldened.
5. Objections from the people. If streets are illuminated every night, such constant illumination will rob festive occasions of their charm.

Following the use of gas for street lighting, it began to be installed in public buildings and finally a few wealthy citizens lighted their homes with it, although it was not until 1865 to 1875 that the use of gas for home lighting began to make any great progress. In 1855, Robert Wilhelm von Bunsen invented the blue-flame gas burner which is still in use today. About the time electric lights threatened to supplant gas, Carl Auer, who studied under Bun-

¹ Committee on Education, American Gas Association.

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sen, discovered the incandescent mantle for which he was awarded the title of "von Welsbach," the name given to his mantle wherever gas is used for lighting today. In 1896, the Welsbach mantel was applied successfully to street lighting.

The first recorded use of gas for cooking was about 1832, but it was not until 1859 that it was used for this purpose to any extent in the United States, and this was done chiefly on stoves imported from England. At the Centennial Exhibition in Philadelphia in 1876, many different types of gas stoves were shown. Since 1895, as the price of gas has been greatly reduced and the cost of fuel appliances brought within the reach of everyone, their use has become general. The public now thinks of kitchens in terms of gas ranges, of which one million are sold in the United States alone every year.

Although it is only a little more than a hundred years since the first gas company was organized in Baltimore, the gas industry today is represented by 966 companies serving 4,600 cities, towns and villages and 9,400,000 customers. In 1924, these gas companies sold nearly 450 billion cubic feet of gas. This was double the amount sold ten years previously and nearly four times as much as was sold twenty years before. In 1927, the total consumption was 1,714,000,000,000 cubic feet. To manufacture this gas 7,400,000 tons of bituminous coal, 960,000 tons of anthracite, 3,800,000 tons of coke, and 933,000,000 gallons of oil were required. More gas is used today in homes for cooking, heating water, and domestic use other than illuminating

than for any other purpose. It is estimated that about 69 per cent of the gas sold is used in this way while 30 per cent is used for industrial purposes. Only about 1 per cent is used for lighting and miscellaneous purposes.

There are more than 91,000 miles of gas mains in the United States, not counting the hundreds of thousands of miles of pipes which lead from the bigger mains to the homes and factories of customers. The investment in the invisible distributing system is usually greater than the investment in the gas-generating plant.

With the coming of the electric light and with the enormous improvements made in this form of illumination, coupled with a steady reduction in costs, gas today is used for cooking and heating purposes rather than for lighting. More than 80 per cent of the gas sold is used to produce heat for many different purposes. It is used for cooking, for heating water and in hundreds of manufacturing processes. To some extent, it is used to heat rooms and even houses. In house heating, it is, of course, a competitor of oil and coal. This subject will be treated in a separate chapter.

A comparison of the burning of raw coal for heating purposes with its use for the manufacture of gas demonstrates at once that the use of coal for heating purposes is wasteful and unscientific. A ton of coal will produce approximately 1,400 pounds of coke (a smokeless fuel), 10,000 cubic feet of gas, 25 pounds of ammonium sulphate, one and a half gallons of benzol and ten gallons of tar. In the manufacture of gas from coal, many other products

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are obtained. For example, it may be difficult to associate delicate perfumes with the odor of gas, yet many perfumes are produced from coal tar, which is one of the products of a gas plant. Dainty dyes, saccharin, valuable oils, ammonia and many drugs and chemicals are made from these products. Thus it will be seen that the burning of raw coal destroys many valuable products which are saved when gas is made from coal.

Coke was once considered a nuisance in the manufacture of gas from coal. Now it is a major product. It is a solid fuel inferior to none and is rapidly supplanting anthracite and bituminous coal for many purposes. As an industrial fuel, it is successfully used for heating furnaces, coke ovens, schools, city and state institutions, factories, office buildings, churches, bakeries, apartment houses, foundries, and for the manufacture of carbureted water gas. Distilling coal in the manufacture of gas for heating purposes is almost like eating one's cake and having it too. There still remains the coke, an even better fuel than coal if properly burned, as well as a host of other valuable products which are totally wasted in the burning of raw coal as a direct fuel.

CHAPTER VII

The Story of Petroleum

PETROLEUM, under many aliases consisting of equivalent terms in other languages, has been known from very remote times and is frequently mentioned in the Bible. In Genesis we find that in one or another of its forms it was used in the building of the Tower of Babel, while Herodotus, writing about 450 B.C., refers to the use of "bitumen," brought down on a tributary of the Euphrates, as mortar in building the walls of Babylon. In Job it is recorded that "the rocks poured me out rivers of oil" and in Deuteronomy mention is made of "oil of the flinty rock" though, as Sir Boverton Redwood says, "both of these expressions may be merely oriental hyperboles for olive oil." In Maccabees it is stated that the priest hid the fire, which they took from the altar, in a deep pit without water and that after many years Nehemiah sent some of the posterity of the priests who had hidden it, and "they found no fire but thick water." This was poured by Nehemiah upon the sacrifices and upon the wood and the altar, and when the sun appeared from behind a cloud it burst into flame and there was "a great fire kindled."¹ "And Nehemiah called this thing Nephthar, which is as much as to say, a cleansing; but many call it Nephai." In the New Testament, Mat-

¹ *A Treatise on Petroleum*, by Sir Boverton Redwood.

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thew makes some remarks which are supposed by many to refer to petroleum. We are even given to understand that Noah used it in the construction of his famous ark—"He pitched it with pitch and covered it with tar."

Plutarch tells us how Alexander was particularly struck with "a gulf of fire which streamed continually as from an inexhaustible source. He admired also a flood of naphtha not far from a gulf, which flowed in such abundance that it formed a lake. The naphtha in many respects resembles the bitumen, but it is much more inflammable. Before any fire reaches it, it catches light from a flame at some distance, and often kindles the intermediate air. The barbarians, to show the king its force and the subtlety of its nature, scattered some drops of it in the street which led to his lodgings, and standing at one end they applied their torches to some of the first drops, for it was night. The flame communicated itself quicker than thought, and the street was instantly all on fire. . . . Still there remains a difficulty as to the generation of this naphtha, whether it derives its inflammable quality from [word missing in the original] or rather from the unctuous and sulphurous nature of the soil." Among other ancient authors who make reference to petroleum are Ctesias, 450 B.C., Aristotle, Pliny and Agricola.

The earliest references to petroleum are connected with the western part of Asia and the eastern part of Europe. The oil of Baku has been known and worked from earliest times and was of much more than local fame. "The everlasting flame," worshiped by the Guebers, or Fire Worshipers, was a

phenomenon about ten miles northeast of the city of Baku. Baku was a flourishing place as far back as the eighth century. It fell into the hands of Persia in the sixteenth century and was not reconquered by Russia until 1806. The "Eternal Flame" is simply natural gas issuing from a horizontal gap in a cleft of rock. Natural gas is still used for burning bricks in this neighborhood. Marco Polo, writing at the end of the thirteenth century, says of the Baku petroleum:

"On the confines towards Georgine, there is a fountain from which oil springs in great abundance, inasmuch as a hundred shiploads might be taken from it at one time. This oil is not good to use with food but is good to burn, and is also used to anoint camels that have the mange. People come vast distances to fetch it, for in all countries round there is no other oil."¹

Baku was the principal city of the Fire Worshipers previous to the Saracenic conquest and was visited annually by thousands of pilgrims; the temple where the sacred fire was maintained was attended by priests from India as late as 1880.

Next to Russia in antiquity are the petroleum fields of the Carpathian range. On the northern slopes will be found the oil fields of Galicia, while on the southeastern and southern slopes, or Transylvanian Alps, are the important fields of Rumania and the less known fields of Hungary and Bukowina.

¹ *Book of Sur Marco Polo the Venetian*, ed. by Col. Yule, 1871.

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The petroleum industry in this area is very old, the earliest records showing that oil was collected in a primitive fashion and used as cart grease and domestic fuel from very early times. Galician petroleum was known as "earth balsam" as far back as 1506 and in local records it is mentioned early in the seventeenth century.

In Italy and Sicily, the oil industry dates from remote times, it having been used for illuminating purposes more than 2,000 years ago. In 1226, a municipal body of an Italian city took for its emblem a salamander surrounded by flames which was supposed to be a symbol of the inflammable natural gas in the neighborhood. In 1400, the first concession for "the collection of petroleum" was granted. In 1640, the celebrated petroleum of Modena, used for lighting and medicinal purposes and in the preparation of varnishes and paints, was discovered about twelve miles from the city. The wells in this territory were from 40 to 60 feet deep and the water that collected in them was covered with light reddish petroleum which was skimmed off once every two weeks.

The earliest mention of petroleum in Germany is in the year 1436 when oil from Bavaria was known as "St. Quirinus" oil and was used as a medicinal preparation. Petroleum has been known in Prussia since the middle of the sixteenth century. Although petroleum and bitumen have been known to exist in France and Switzerland for at least two centuries, no commercially profitable deposits have been found except in Alsace. The oil fields of Alsace, taken from France by Germany, were restored to that

country as one of the results of the World War. Petroleum occurs in several localities in Spain, but there has been little or no development.

In Egypt, the oil deposits of the Red Sea have been known from time immemorial and were called by the Romans *Mons Petrolius*. In Persia, petroleum has been discussed by various writers from the time of Herodotus. One of the most famous springs described by Herodotus was at Kirab. In India, crude petroleum, smoky and foul-smelling, has been burned for more than 2,000 years. The natives preferred to burn fish oil in their lamps until they began to obtain supplies of refined petroleum from the United States. The largest sources of petroleum in India today are found in Burma. Petroleum and natural gas were both in use in China and Japan long before the Christian Era. In fact, it may be said that nearly all the ancient peoples stumbled on petroleum in one form or another, and the fact that it could be used as fuel and also that it had certain medicinal properties has been known for literally thousands of years. It remained, however, for the ingenuity of Americans of the past generation to develop its possibilities.

Before the coming of petroleum in the United States, the colonists burned candles or whale oil.¹ Whaling ships sailed from various New England ports for voyages of one, two or three years, killed thousands of whales and returned with thousands of barrels of whale and sperm oil. Sperm oil was the best lamp oil, and sperm candles were found in every

¹ See "Striking Oil" by Guy E. Mitchell, writing in *A Popular History of American Invention*.

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home. As so often happens with natural resources, the demand rapidly exceeded the supply and whales became more and more scarce. But even in those days, the scientist was always waiting around the corner for an order for some kind of substitute, and inventors produced among other compounds a mixture of turpentine distilled from pine sap and alcohol which was called camphine.

In the meantime, James H. Young, a Scotchman, began experimenting in 1847 with oil distilled from coal. In 1854, an American chemist, Dr. Abram Gessner, patented an improved illuminating oil which he called kerosene, which was obtained from coal. Before his time, all illuminating oil was known as coal oil, but later Gessner's name "kerosene" was applied to refined petroleum used for lighting and for many, many years the kerosene lamp was considered the ideal light; it is still in use in many rural sections.

According to tradition, petroleum was first discovered in the United States by a Seneca Indian squaw. Noticing the beautiful iridescent colors of oil floating on the surface of a creek, she dipped her blanket in it in the hope that she might transfer those colors. Squeezing out the oil, she found it useful for many purposes. The Indians began to store the oil in pits timbered with rough-hewn beams and posts—the first storage of petroleum in America. The white settlers were not long in following the methods of the Indians in obtaining and storing oil. "Two men working together," Mr. Mitchell tells us, "gathering the oil and wringing it out of a blanket, would harvest perhaps a barrel of oil a day. For

many years this product, duly bottled and labeled 'Seneca Oil,' 'Indian Oil,' or 'Snake Oil,' was sold by druggists for both internal and external use as a cure for all ailments."

George Washington was one of the first men in America to realize petroleum's possibilities. Visiting western Pennsylvania in 1753, more than one hundred years before the first oil well was drilled, he learned of the existence of petroleum and quickly recognized its importance. Later he acquired some oil lands and in his will he listed among his most valuable holdings lands which included a "burning spring." In this will he said:

"This tract was taken up by Gen. Lewis and myself on account of the bituminous spring which it contains, of so inflammable a nature as to burn as freely as spirits and is as nearly difficult to extinguish."

Some historians claim that Washington in an earlier will dedicated his burning spring to the public. Later, however, he sold the lands, including the spring, for \$200,000, but, suspecting they might revert to his estate, warned his heirs that they would be worth more than \$200,000.¹

Fully a century before Washington's mission into Pennsylvania, French missionaries and English explorers had discovered oil and its use by the Indians both for heating and lighting, and reported it of great value. It is also established that a prehistoric race in America, probably the mound builders, had

¹ *Washington's Early Adventures in New Historic View*, by Henry Botsford.

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known oil. It was also known to the ancient races of Mexico and Central America.

The idea of obtaining petroleum from wells drilled just as water wells are drilled was first suggested in 1856 by George A. Bissell, a New York lawyer. Prior to that time, some petroleum had been obtained from wells drilled originally for the purpose of obtaining salt water. It occurred to Bissell that if salt water could be obtained from wells with a little oil as a side issue, they could be drilled down into the rocks and produce mostly oil. This was another brand new idea in which the people at that time had little faith. In 1858, he and his partner, Jonathan G. Eveleth, formed the Seneca Oil Company and engaged Colonel E. L. Drake as superintendent. Drake also believed that oil was to be found in great underground pools from which it could be obtained by drilling.

After many failures and discouragements, Drake engaged a salt water well-driller known as Uncle Billy Smith. With his two sons, Uncle Billy began work on May 20th, 1859. At 69½ feet, they noted oil rising in the drive pipe and Smith notified Colonel Drake that his fortune was coming up the pipe. The news quickly reached the little village of Titusville and when Colonel Drake arrived the next morning, he found Uncle Billy and his boys guarding several barrels of petroleum. A pump was immediately installed and by October the well was yielding 20 barrels a day. On October 7th, the tanks and derrick burned to the ground, having caught fire from a lamp in the hands of Uncle Billy.

Refusing to be discouraged, Colonel Drake im-

mediately built a new derrick and started pumping again. The well was soon producing 30 barrels a day, a rate which it maintained for several years. This first well, which did not produce enough oil to supply a country village today, broke the oil market. Oil had been selling for \$2.00 a gallon and the price immediately dropped to \$1.00 a gallon, or about \$40.00 a barrel. Two more wells were drilled on the Drake tract and several on adjacent tracts. Two years later, the first flowing well was struck which produced about 300 barrels a day. Shortly after, the Phillips well on Oil Creek came in with 3,000 barrels a day.

Drake is often spoken of as the discoverer of petroleum, but nothing could be further from the truth. We have seen that petroleum had been known and prized for thousands of years and had been crudely refined. There were at least six small refineries in Pittsburgh before Drake produced petroleum from a drilled well.¹ In Scotland, James Young had been producing petroleum from oil shale. However, Drake's discovery that it could be produced in large quantities from drilled wells was the foundation of our modern oil industry.

With the flood of petroleum which quickly followed came improvements in methods of refining with great rapidity. Crude oil is refined by a distillation process. Heat is applied and different compounds are boiled off at different heats. At the lower temperatures the lighter compounds are obtained, and as the temperature is gradually raised,

¹ Henry Botsford.



THE EGYPTIANS BURNED A FIRE OF DRIED VEGETABLE MATTER ON A HEARTH IN THE MIDDLE OF THE FLOOR

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the heavier compounds are distilled off. In this manner benzine, gasoline, kerosene, distillate fuel oil, heavy lubricating oils, paraffin and asphaltum are successively obtained. Kerosene and gasoline are not chemical terms but simply names. The earliest refiners wanted as much kerosene as possible and considered gasoline a nuisance. For this reason, their kerosene was almost as explosive as our gasoline and laws were passed forbidding the sale of kerosene that was too light. Now, with the millions of motor cars demanding gasoline, the refiner is selling gasoline that is often more like the kerosene of the old days. This tremendous demand for gasoline has brought about, among many improvements in refining, one which is called "cracking."

Heat acts upon petroleum exactly as a hammer acts upon stone. It breaks it up. The pieces are called benzine, gasoline, kerosene, etc. These pieces are very large and complex, chemically speaking. It was found that by applying heat under pressure, petroleum could be "cracked up" into much smaller pieces. As far back as 1860, chemists were trying to devise ways to apply heat to petroleum under pressure, but it was not until the automobile demand for gasoline created a real crisis that any serious industrial effort was made to crack up kerosene and similar heavy oils into lighter gasoline. William M. Burton, a noted chemist of the Standard Oil Company, worked for years on the cracking idea to obtain more gasoline and in 1913 secured a patent for a cracking process which is used extensively at the present time by the Standard Oil Company. It

marks one of the milestones in the history of petroleum refining.

With the rapidly increasing production of crude oil, improvements in methods of refining and the constant discovery of new uses, thereby increasing the demand, came many problems, not the least of which was the problem of transportation. In the early days, thousands of teamsters were employed to haul tens of thousands of barrels to the nearest railroads. Hundreds of boats, tied together as rafts, carried twenty to twenty-five thousand barrels down Oil Creek to the Allegheny. Later, railroads were built into the oil regions, but for years it was a question whether the oil wells would not dry up and leave these roads with nothing to transport. At first, oil was shipped in barrels, later in tank cars, and finally in pipe lines.

The first tank car was crude enough and was conceived by Charles P. Hatch of the Empire Transportation Company about five years after Drake's well had struck oil. At his request, his company sent him a box car in which had been built three wooden tanks. Within a few years, long lines of tank cars had taken the place of wooden barrels on railroad sidings. Today, there are some 138,000 oil tank cars, enough to store all the oil which was produced in the United States in 1880.

As far back as 1860, S. D. Karns proposed the laying of a six-inch pipe from Burning Spring, West Virginia, through which oil would flow downhill to the Ohio River, thirty-five miles away. This line was never constructed, but two years later, L.

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Hutchinson laid three miles of small pipe from the Sherman well to the railroad. This line was a failure because of excessive leakage. The first practical pipe line was laid by Samuel Van Syckle of Titusville, the sections of which were screwed together. It was less than four miles long and carried 80 barrels a day.

In 1866, Charles P. Hatch, the same Hatch who had demonstrated the practicability of the tank car, operated the first regular pipe line in the United States from the Pithold oil district to Titusville. It was ten and a half miles long and belonged to the Empire Transportation Company. It was built with three pumping stations and Hatch believed that one pump would force the oil the entire distance, although no one else thought so and the teamsters and old oil boatman laughed at him. But he was right and he proved that the problem of long-distance pumping of oil through pipes was solved. The line could pump 2,000 barrels a day, and the teamsters who saw their business evaporating into thin air often cut and plugged it.

Soon other pipes were laid and the lines grew rapidly in length. In 1874, J. J. Vandergrift and George W. Foreman completed the first oil trunk line from the Pennsylvania oil region to Pittsburgh—a line of four-inch pipe, sixty miles long, and capable of carrying 7,500 barrels a day. Trunk lines were then laid from the various oil fields to Cleveland, Buffalo, New York, Philadelphia and Chicago. Today, there are 40,000 miles of main oil pipe lines and another 40,000 miles of tributary

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or gathering pipes, making 80,000 miles in all. Most of the trunk pipe lines are eight inches in diameter, with a pumping station on an average of every fifteen miles. Through the average pumping station with an eight-inch pipe, 30,000 barrels of oil are pumped every twenty-four hours. The longest continuous pipe line reaches from gathering points in Texas to the refineries in Bayonne, New Jersey. It takes the oil in this line sixteen or seventeen days to reach its destination. Simply to fill the pipe-line system of the United States would take more than 14,000,000 barrels of oil. The cost of this great network has been more than \$750,000,000.

The oil industry is characteristically an American industry and to this, perhaps, is due its dominant place in the world. An Englishman, writing a history of the oil industry, said of America's part in it:

"This volume is an Englishman's tribute to the engineering skill and resource and bold financial enterprise of the world's most splendid race of oil men—those who have built up the American part of the industry. Today they and their country are absolutely supreme in oil."

It is due to this fact—for it is a fact—that the people of the United States possess 23 million of the 27 million automobiles throughout the world and that the automobile has become a necessity rather than a luxury. It is due to this fact that hydro-electric power cannot compete with oil-burning steam plants in California. It has made a tremendous contribution to the fact that American industry

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leads the world today. And finally, but by no means the least important, it is due to this fact that the householder in a well-equipped house has no more to do with his furnace than the setting of the thermostat at the required heat.

CHAPTER VIII

Petroleum Today and Tomorrow

"DAY before yesterday Britain was the great industrial country, largely because of coal. But the world has passed on from coal to petroleum; and America has the petroleum." Thus writes Judson C. Welliver in the *Review of Reviews* under the caption "Oil: The New Industrial Giant."

The coal age is passing and the oil age is here. Petroleum, as a basic American industry, is second only to agriculture, to which one may add that no less than 70 per cent of the total petroleum industry of the whole world is in the United States. There are more than eleven billion dollars invested in it, which is half the total valuation of all the railroads, is twice the investment in the steel industry and 2 billions more than is invested in the electric light and power business. Of the 800 million mechanical horse power used in this country, at least half, in the last analysis, is derived from petroleum.

There is nothing quite so tiresome as statistics. So many statisticians seem to be almost totally lacking in terminal facilities; they always seem to be on their way but they so seldom know where they are going and, like the old negro on the merry-go-round, "jes' ride an' ride and don't git no-where." Basic figures of production, however, are not susceptible to manipulation by even the cleverest of human cal-

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culating machines, and the author is almost compelled to give a few of them with regard to the oil industry in order to substantiate the statement that as a basic industry it is second only to agriculture.

About $2\frac{1}{2}$ million barrels of petroleum are taken out of the ground every twenty-four hours. This is nearly a billion barrels a year. If a single day's production had to be moved by rail, it would require 10,000 tank cars to be loaded daily, and before a month passed, there would be a complete paralysis of our transportation system. Ninety thousand miles of pipe line move the bulk of this oil for a small fraction of the cost of hauling it by rail. These billion barrels of crude oil produce about 325 million barrels of gasoline, about 500 million barrels of fuel oil and oil for making gas for illuminating purposes, the balance producing lubricating oils and a thousand and one valuable by-products.

There are today about 300,000 oil wells in the United States scattered over twenty states and Alaska. Most of these wells produce from a fraction of a barrel to a few barrels a day. One-fourth of them are in Pennsylvania, yet Pennsylvania produces only about 2 per cent of the oil. California has only 4 per cent of the wells but produces almost 30 per cent of the oil. Oklahoma produces 25 per cent and Texas 21 per cent of the oil. Half of the oil comes from 6,900 wells and the other half from 304,000 wells.

There are certain factors in connection with the production of petroleum which are peculiar to the industry. For example, early in 1927 a huge flush production of 330 wells in two new fields upset the

whole price structure; and any day a new field may be discovered which may produce so heavily as to swamp the market. Overproduction of petroleum does to prices exactly what overproduction of cotton will do to cotton prices. But when a new field is opened, it must be drilled as rapidly as possible if each landowner of territory above which the oil is discovered is to get his share of the oil. This means unrestricted competition and represents a serious problem for both the government and the industry itself.

"How overproduction affects the market is a simple story," says Mr. Welliver. "The refiners squeeze products out of the cheap and plentiful crude, till the market cannot absorb them. Then price cutting starts: 'boot-leg' gasoline gets to distributors at distress prices; filling station prices are slashed, and motorists wonder how one pump keeps the price up several cents above another near by. It is all quite inevitable under a regime of such sharp competition as exists throughout the business. And it *does* exist. Excessive production of crude will bring lower prices at the filling station in an amazingly short time."

Once out of the ground, the petroleum must be refined; that is, reduced to its many useful constituents. A modern refinery, capable of handling 125,000 barrels of crude a day, is one of the most complex industrial establishments in existence. In 1927, there were 465 refineries capable of handling 3,061,007 barrels of crude oil a day. As recently as 1914, only about one-sixth of a barrel of crude oil was made into gasoline. With modern methods of

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refining, this proportion has been greatly increased, so that now nearly 35 per cent of all crude oil becomes gasoline. The efficiency of American methods is demonstrated by the fact that in Roumania they get only about 5 per cent of gasoline, and they are just beginning to install "cracking" processes which will raise the recovery to 10 or 11 per cent.

In spite of the fact that domestic consumption has increased more than nine times since 1913, gasoline, by comparison with the general price level, is about the cheapest commodity of general and extended use. It is comparable only with electric light and power. Since 1913, there has been a general advance in the average price of all commodities of about 51 per cent. Gasoline has advanced only about 18 per cent. Therefore, by comparison with the general price structure, gasoline in 1926 was cheaper than it was before the war.

There has been much complaint on the part of the motoring public about price variations in different parts of the country, the implication being that the motorist is charged as much as the traffic will bear. In 1927, Mr. Welliver made an exhaustive inquiry into these complaints. He took filling-station prices of gasoline throughout the country on a certain date, and retail prices of staples generally, as reported by the Department of Labor. He says:

"The results were curious. On the given date, sirloin steak sold at retail in San Francisco at 30 cents a pound, and in Buffalo at 47 cents; a difference of 39 per cent. But on

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the same day, gasoline sold in San Francisco at 18 cents, ex-tax, and in Buffalo at 19 cents, a difference of only $5\frac{1}{2}$ per cent. Gasoline was 18 cents in both Dallas and Chicago; but sirloins were 33.6 cents in Dallas, against 46.4 cents in Chicago, a difference of 38 per cent.

"Or take potatoes: at retail, they cost in Dallas 5.2 cents per pound, in Chicago 3.3 cents; a difference of 58 per cent.

"Again, excluding tax, gasoline was 20 cents at both Birmingham and Boston. But sirloin steaks were 69.6 cents in Boston, 39.6 cents in Birmingham, a difference of 75 per cent. Potatoes in Boston cost 3.2 cents a pound, and 5.3 cents in Birmingham; difference, 52 per cent.

"Portland, Oregon, showed gasoline, ex-tax, 18 cents; in Washington, D. C., it was 20 cents; difference, 11 per cent. But sirloin was 28.4 cents in Portland, against 47.3 cents in Washington; difference, 66 per cent.

"Take a different sort of illustration. At Cincinnati, the rental of a house fitted for a family of \$900 to \$1,200 income was \$156.46; at Columbus, Ohio, \$174.22; at Cleveland, \$202.04. But at all these Ohio cities, gasoline sold at 19 cents, ex-tax."

It would seem therefore that there is little merit in the claim that the variation in the price of gasoline in different sections of the country is greater than the variation in the price of other staples.

What does the huge production of crude oil mean

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to the American people? First, it supplies 23,000,000 automobiles with cheap, high-grade fuel. It is because of the tremendous supply of gasoline at a price where all may buy that the United States has more than 80 per cent of all the motor vehicles in the world. If we had to pay European prices for gasoline, the story would be quite different. It is because a far-seeing oil industry has been bending every effort to find markets for the other products of petroleum such as fuel and lubricating oil that the price of gasoline is kept down below the pre-war level.

Second, it furnishes the railroads with a huge tonnage, thereby making its contribution to the keeping down of freight rates. One-sixth of the car-load freight tonnage of manufactured products handled by American railroads is "refined petroleum and its products." The petroleum products which are moved by rail are more than twice those of any other group of manufactures; 150,000 tank cars are required to move in bulk the liquid products of petroleum, besides tens of thousands of ordinary freight cars which are used to transport package shipments and nonliquid products.

Third, it has made the Panama Canal a paying enterprise. When Roosevelt started building the canal, nobody thought it would pay for generations. Now, though it has been in operation only about ten years, it pays interest on the investment, operating expenses, and turns millions annually into the United States Treasury. Oil is the greatest patron of the Canal. In 1926, no less than 1,262 oil-tank ships with 7,117,408 tons of freight paid tolls of

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\$6,447,399.40, or 28 per cent of all the net tonnage and 26.9 per cent of all tolls. Petroleum has put the Panama Canal on the map.

Fourth, it furnishes employment to a vast army of people. There are no satisfactory data on the number of people employed in the industry; it has grown too fast. But one company which does about 10 per cent of the entire business has 110,000 officials and employees and at this rate there are at least 1,100,000 employees in the entire industry. To this must be added operators of filling stations, the number being estimated at 225,000.

Fifth, it is responsible for a tremendous diffusion of income. The stock and bondholders, owners of royalties, etc., are estimated at 1,500,000. The great number of investors and royalty owners make the industry an exceptionally wide distributor of incomes. One-eighth of the crude oil goes to the landowner as royalty, which means over \$150,000,000 a year.

Sixth, the rapid increase in the demand for gasoline has resulted in a heavy increase in the production of fuel oil. This has stimulated invention in the fuel oil burner field, has resulted in methods of burning fuel oil which have reduced the cost of power to industry and added immeasurably to the comfort of the householder. It is by stimulating the market for fuel oil that the price of gasoline is held down and waste in petroleum production eliminated.

But, say the American people, if production is permitted to go on without restriction, how soon will it be before our oil reserves are exhausted? The

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report of the Committee of Eleven to the Board of Directors of the American Petroleum Institute gives us some interesting data on this subject.

The report on supply estimates a future production of over $5\frac{1}{4}$ billion barrels of oil from existing wells and from the acreage which these wells prove to be oil-bearing by present methods of flowing and pumping. It also estimates, however, that there will still remain in this acreage 26 billion barrels of oil when the pumping and flowing in present fields shall have ceased, most of which can be recovered by known methods.

The oil-producing and proved area in the United States totals 3,244,581 acres now yielding about $2\frac{1}{2}$ million barrels a day. But there are in the United States over a billion acres of land of geological formation favorable to the presence of oil. Within this area, many new oil fields will undoubtedly be found.

It is estimated that there are within the United States 394 billion short tons of oil shale from which about 108 billion barrels of crude shale oil can be recovered. This will produce about 25 billion barrels of motor fuel.

There is a minimum of 525 billion barrels of liquid products which can be secured from the country's coal deposits yielding about 92 billion barrels of motor fuel.

It is estimated that 70 billion barrels of liquid products can be obtained from the country's lignite deposits yielding about 12 billion barrels of motor fuel.

So it would seem that for some years to come we

need not be unduly alarmed about the prospect of having to get along without oil.

This does not mean, however, that the oil industry should ignore the principles of conservation or that there should be no consideration given to the economics of the use of petroleum. There is no reason why, just because we are assured of an ample supply for an almost indefinite period, we should forget the lesson of the history of our American forests.

There is no "waste" *per se* in the oil industry. The day has gone when unconsumable products—such as gasoline was in the past—are thrown away. The modern refinery succeeds in using every element of crude oil and in the case of the cracking process has performed the hitherto unheard-of task of changing one grade of oil into another to make the supply conform to the demand. The only element of waste in connection with producing oil is the forcing of competition by the drilling of unnecessary wells and the methods of handling oil. To remove completely this kind of waste, it will be necessary to modify various antitrust laws.

What has the future in store for this great industrial giant? It would seem that with ample future supplies and with a constantly increasing demand for its many products, it need have no concern. But, as Hugh Farrell in *What Price Progress* tells us, all industry must keep pace with science. In fact, any industry, if it would keep faith with the public and with its investors, must keep about two jumps ahead of science. At any moment some chemist or physicist may hit on something that will knock it into a cocked

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hat and turn valuable interest-bearing stocks and bonds into so much worthless paper.

Suppose, for example, some American or French or German chemist should come along with a synthetic fuel for automobiles which is better and cheaper than gasoline. This is not only within the range of possibilities but almost within the range of probabilities. It is already being seriously discussed. According to recent announcements, a giant plant is being built in Germany which will produce 50,000,000 tons of synthetic petroleum annually at first, and in a few years 120,000,000 tons. The process provides for the conversion of coal. The Germans feel that they were beaten in the late war largely by American petroleum and want to be as independent of oil as they were in 1914 in the matter of explosives through the invention of synthetic nitrates.

American chemical engineers say that synthetic methanol can be produced in this country at a much lower cost than 18 cents a gallon, the lowest cost mentioned being 4 cents. Paris reports say that French chemists working on the synthesis of methanol have already discovered traces of gasoline or a product resembling gasoline. Does this mean that the oil business may be put out of business? Hardly. It is more likely to mean quite the reverse. Let us see what Mr. Farrell says:

“Nobody knows just what petroleum is. The chemical possibilities of petroleum within the field of its constituents are practically limitless.

You wouldn't believe that potable alcohol carrying a wallop that would floor a longshoreman could be made from petroleum, but it has been done. A whole string of alcohols of the very highest industrial grade have been made from petroleum and alcohol is only one of the hundreds of things that are believed to be hidden in it."

Again, the discovery of some synthetic motor fuel might easily bring about a reversal of the processes of refining petroleum. We have seen that in the early days gasoline was considered a nuisance and the refiners recovered as little of it as possible. Later, with the tremendous demand for gasoline, there came the danger of a great surplus of fuel oil with all its storage problems. Now the demand for fuel oil both for industry and domestic use is increasing by leaps and bounds. If gasoline as a factor in the oil industry should pass, a higher percentage in the production of fuel oil might easily take its place and fuel oil, as a competitive fuel, occupy the center of the stage. All of which would be to the everlasting benefit of the householder concerned with the problem of heating his home as economically as possible, and to the benefit of industry concerned with the problem of more and more and cheaper and cheaper power.

Although the petroleum industry employs hundreds of chemists, it has never done much research work. This is not going to remain true. John D. Rockefeller has set aside \$250,000 which, with \$250,000 supplied by the Universal Oil Products

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Company, is to be used exclusively for research into the fundamentals of the petroleum industry; this money will be spent trying to find out what petroleum really is, its origin, its content and also for studies of possible substitute fuels.

CHAPTER IX

The History of Heating With Oil

IT IS a human trait to consider any industry in terms of its present development and forget that in most cases its product is simply the progeny of some other industry or some fabricated article intended for the same purpose and which preceded it. Thus when we speak of oil heating, the first thought is of the automatic oil burner in the furnace in the basement, which is a development of the past ten years. But the automatic oil burner, keeping the entire home at an even and any desired temperature, was preceded by the "portable" oil stove which could be carried from room to room and which in turn was simply a development of the oil lamp of Biblical days. At least 90 per cent of these portable stoves, which even today are being manufactured and sold in large quantities, make use of a wick, while the principle of feeding oil to the flame is the same as it was in the days of Moses—that same Moses who led his people out of Egypt.

The earliest oil lamp, or heater, known in history, simply made use of a bit of rag or cord for a wick, while the fuel was any hydro-carbon oil of either animal or vegetable origin. The piece of string or rag was placed in a dish of oil or grease of some kind and the evaporation of the oil due to the heat from the wick caused the oil to draw up the

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wick and feed the flame at the top. No attempt was made to control the amount of flame, and the only method of getting a larger or smaller flame was to use a larger or smaller wick. These lamps or stoves were evil-smelling and lacking in efficiency.

In later days, when whale oil, coal oil, and other mineral oils became common, great improvements were made in the oil lamp. After many years of experimenting, it was found that by placing a certain length of chimney over the flame and allowing air to be fed to the flame in certain ways, constant temperatures would be maintained and a clean white steady flame would be the result. The first lamps of this type used flat wicks which could be elevated or lowered according to the amount of flame desired. When it was discovered that in order to secure a larger volume of flame for lighting or heating purposes it was necessary to use a larger wick, inventors hit on the idea of making the wick circular or in the form of a hose. This type of lamp, frequently called the Argand type, was the grandfather of present-day portable oil heating stoves.

The early oil heaters and cook stoves made use of the yellow flame controlled exactly as the flame of the oil lamp was controlled, but were fitted with wicks of a much larger diameter. The flat wick stoves were called "lamp type" and were sold at very low prices all over the country. The cook stoves were built with low chimneys so that utensils could be placed as close to the flame as possible, and were not very satisfactory. If the burners got dirty or if the wicks were not kept properly trimmed, the flame would be ragged, producing smoke and almost

unbearable odors. The burners often became overheated, causing an increase in the size of the flame, producing much smoke and unpleasant odors.

Prior to 1890, little or no attempt was made to correct the many faults of the oil stove, whether for cooking or heating. In 1893, however, James Atkinson took out patents on what is known as the blue-flame wick burners. His efforts were followed by Coradino, who took out patents in 1899, and these two men appear to be the fathers of the present blue-flame wick stoves. Another type of cook stove which is sold in fairly large quantities today is the "short drum" or high-burner type. This is claimed to be a modern stove and an improvement on the blue-flame wick type. As a matter of fact, the short drum or "monoxide" type of burner was developed long before Atkinson and Coradino attempted to produce a blue flame in the lamp type stove. The records of the United States Patent Office show that Mr. C. F. Morrell developed this short drum or monoxide burner between 1855 and 1870 and that this early burner had all of the essential features of the present-day successful short drum stove. He used an adjustable wick capped with removable outer and inner commingling tube and was able to produce a beautiful blue flame, equal to the flame produced today by the short drum stove.

The type of stove which had some measure of popularity some years ago was a short drum type used without a wick and commonly called the "wickless" stove. It had a great many faults and required great care in setting up in order to produce equal results on all of the burners. This and other

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troubles gradually forced it from the market. A great many attempts have been made from time to time to get away from the wick and burn kerosene in some other manner. Stoves built on the pressure vapor principle—similar to a plumber's torch—have found some market in Europe but have never seemed to be successful in this country, owing to the amount of trouble experienced in keeping the working parts in operating condition.

In the case of the present-day portable oil heating stove, the old style "yellow" flame is still in use but with draft spaces so arranged that the burner can be kept at constant temperature. In the case of the oil cooking stove, there is a mixing of air so as to give a beautiful blue flame with white points. The combustion in either a modern oil heating or cooking stove is so perfect that they can be burned in closed rooms for hours at a time without in any way poisoning the air, the only ventilation necessary being for the purpose of supplying oxygen to the burners and to the occupants.

In spite of the tremendous developments in the use of gas and electricity, in house heating, both by the use of coal and of oil for fuel in furnaces, there is still a tremendous and even growing demand for the oil cook stove and the portable oil heater. These stoves have been perfected to such a point that the country dweller, to whom gas, electricity and even coal may not be available, can be quite as comfortable as the city dweller with his coal or gas or electricity. They are, of course, by no means as convenient as the gas range or the automatic oil heater installed in the cellar, and they require more atten-

tion, but they do give service of the most satisfactory sort. In fact, American oil cooking and heating stoves are being sold all over the world in constantly increasing quantities.

These types of stove burn the lighter oils—what are commonly called kerosene, or naphtha or coal oil. From time to time, efforts have been made to manufacture and popularize a stove which uses gasoline, and there are some successful stoves of this kind on the market. The oil stove, however, does not have the element of danger ever-present in the gasoline stove of the past and is much cheaper to operate.

While these developments were going on, there have been other interesting developments in scientific oil burning during the past two generations in the direction of burning the heavier fuel oils. Mr. H. W. Werty, writing in the *Fuel Oil Journal* gives a brief but interesting account of these.

According to Mr. Werty, oil has been burned for heating purposes, haphazardly, down through the ages; but it has only been in the last two generations that any progress has been made toward scientific oil burning. Before the Civil War the burning of oil on a large scale was regarded as impracticable; the idea of attempting to burn the liquid had apparently not occurred to anyone.

A great many people get a certain amount of smug satisfaction in thinking and speaking of Russia as a backward nation. It is true that Russia is backward in many ways. It is sadly lacking in modern methods of transportation and communications and it is even more lacking in educational facilities for

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the great mass of the people. It is this lack of transportation, communications and education that has made possible the present rather disastrous experiment in the theories of Karl Marx. Nevertheless, Russia has given many things to other and seemingly more progressive nations, and the fact is that many of the first oil-burning devices appeared in this country. The existence of the heavy oil in the Caucasus region, ideal as fuel, greatly helped Russian experimentation.

To a mechanic named Werner, employed in a Russian refinery, should go the credit for having first suggested that refuse oil, which corresponds to our heavy fuel oil, be burnt as fuel. In 1861 he experimented with numerous devices and finally settled on a contrivance consisting of a series of grates, or griddles, over which the oil trickled and burned. It was patented in 1867 and had a wide use. The Russians called this refuse oil "astatli" and it existed in such large quantities that its disposal presented a serious problem.

"American inventive genius [continues Mr. Werty] did not lag far behind, and in 1862 Shaw and Linton patented a furnace in which oil fuel was conveyed into the interior in a gaseous state, it having been previously heated and made to give off lighter oils, which subsequently were consumed in the furnace. A method used a trifle earlier consisted of a pan, or step, over which the oil flowed and was ignited.

"In 1863, the first spray burner was intro-

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duced in America by Brydges Adams. About the same time, an 'oozing' furnace was brought out in England by Richardson. The oil was fed to the interior after having traversed a bed of lime through which it was drawn by capillary attraction.

"A new era in oil burning dawned in 1865, when Ayden, Wise and Field introduced the first nozzle feeder in London. However, the honor of inventing the first really practical burner rests between Ayden and his associates and a Russian named Spakovsky, the latter using a blast of hot air to atomize the oil, whereas the Ayden device employed superheated steam. The Russian patented his device in 1865.

"Around 1870, another Russian refiner perfected a burner which he hoped would help him find a market for his heavy refuse oil. It was crude compared with the modern burners, but it served its purpose. He atomized the heavy oil by introducing it into a heavy tube through which a high-pressure jet of steam was directed which, by its high velocity, broke the oil up into spray.

"As late as 1878, another type of the oozing furnace was brought out in New Jersey, but by this time most of the more primitive types of burners had been abandoned in favor of the spray and the jet. The inventions and the reasoning of the pioneers in this style of oil burning were subject to ridicule by their pred-

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ecessors in many of the treatises written between 1890 and 1900.

"Since 1883, the progress has been much more rapid and the number of different types of burners that have been introduced is very large. Each year has seen an improvement.

"One of the early burners which attracted attention was designed by Baskakoff, a Russian, who introduced a stove for housewarming with a soot formation of only .0003 per cent of the total amount of fuel used, and without the aid of atomization. This stove was awarded the gold medal of the Imperial Russian Technical Society. Thomas Urquhart, an American connected with the Russian Railways, in 1884 perfected a method of spraying oil with steam and this was used as a pattern by other inventors for some years.

"The Columbian Exposition at Chicago in 1893 gave great impetus to the use of liquid fuel in America. All boilers there were arranged with fuel oil only."

In another chapter will be found a description of the many uses of fuel oil in industry. In the next chapter will be found the history of the development of the oil burner for heating residences, apartment houses, hotels, factories, etc.

CHAPTER X

Story of the Development of House Heating

THE history of American inventive genius for the past twenty years is filled with stories of labor-saving devices for the home, all of them apparently intended to lighten the labors of the house-wife and, as Leod D. Becker, director of the Oil Heating Institute, has put it, conserve woman power. There have been electric irons, washing machines, dish-washers, vacuum cleaners, sewing machines, refrigerators, and a great variety of other things calling upon electricity to do those things which have been heretofore done by hand and at the cost of much physical labor.

Artificial heat has always been a prime necessity for those who would live anywhere except in tropical or semitropical climates. It is, in fact, as essential to comfort and health as clothes or food or even shelter. In fact, in extremely cold climates, shelter would be of little value to civilized man if it could not be heated. How many of us could withstand the rigors of a winter in the extreme North without some sort of fire?

We have seen how primitive man, as soon as he discovered that he could preserve and control fire and then that he could kindle it at will, was able gradually to migrate from climates where no artificial heat is needed into the colder climates. When



THE INDIANS CONNECTED THE HEAT OF THEIR OPEN CAMP FIRES WITH LIFE-GIVING WARMTH
OF THE SUN

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it was new to him, he built his fire on the floor or just without the door of his cave, using it for cooking and to supply a little needed warmth. As he progressed from a cave dwelling to rudely built dwellings, he was bothered at first by smoke but soon learned to cut holes in the top of his house and thus dispose of it. As his house progressed from the crude to the plain, to the comfortable, even to the luxurious, his heating problem became more complicated. He could no longer leave holes in the top of his dwelling, and he had not yet invented the chimney. Old records indicate scattered usage of the chimney as early as 300 B. C., but it is not probable that chimneys were generally used before the twelfth century. About this time the use of fireplaces for heating the home became popular and have continued to this day.¹

By this time, however, man was becoming more and more insistent that things designed primarily for his comfort should be more and more efficient, and the fireplace, with no other form of heat, never was and is not today efficient. It radiated heat only to the front and its area of radiation was small. So he set about to increase this area by enclosing his fire in materials that would radiate the heat and move it out into the middle of the room, or at least away from the wall. Thus the stove as we know it today was born.

But man was not satisfied and demanded more and more of fire. Chimneys would carry off the smoke and also provided the draft which made his fire burn freely. But only the rooms equipped with

¹ *Warm-Air Furnace Heating*, by A. M. Daniels.

stoves were heated and these were only partially heated. Close to the fire, the heat would be intense, while in the corners the temperature would be extremely low. Many of us can remember the old-fashioned schoolhouse with its great pot-bellied stove in the corner. Those fortunate enough to have a seat near that corner were uncomfortably warm, although they were not nearly so uncomfortable as those in the corner farthest away from it.

So man turned his attention to heating all parts of the room alike, which eventually resulted in the central fire in the cellar, the heat from which was transmitted by either air or water. This is the principle of our present system of heating, whether it be by warm air, steam or hot water. There is a great period of development, however, between the original conception and application of the idea and the systems in use today.¹ Each type of system has passed through a period of gradual improvement from crude construction to its more efficient construction and from its wasteful utilization of various types of fuels to the automatic oil heater of today which makes use of every bit of the heating content of fuel oil.

"The first furnace in New England along the lines of our present-day furnaces," says Mr. A. M. Daniels, "is believed to have been built in Worcester, Mass., in 1835. It was termed a 'hot-air' furnace, which term was commonly used until a few years ago, when it was properly changed to 'warm-air' furnace."

"Although the beginning of the warm air indus-

¹ *Ibid.*

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try dates from approximately 1835," continues Mr. Daniels, "its progressiveness most emphatically does not. Furnaces were manufactured and warm-air heating systems were installed without any knowledge on the part of the manufacturer or installer as to what the systems were capable of doing or methods by which the best results might be obtained."

But while warm-air heating from a central fire which would heat all of the rooms in the house and heat each room with a fairly even temperature was an enormous improvement over the fireplace and the stove, man was not yet satisfied. It is only one more instance of progress due to dissatisfaction. And so the first steam-heating and hot-water systems were born. These systems were a great step forward because of the possibility of continued heat with fires wholly or partially banked. It removed some of the drudgery of running a furnace. Except in the most severe weather, it became possible to get the house warm in the morning and then fix the fire so that it would last all day.

Still man was not satisfied. He now had a comfortable heating plant which was extremely efficient but there still remained a great deal of drudgery. Fires had to be built; fuel had to be stored in the cellar; the fire had to be tended, shaken down and the ashes removed; and every so often the ashes had to be carried out of the cellar. There is hardly an urban householder in the United States, except those so fortunate as to be able to afford a furnace man, who is not familiar with the drudgery—I almost said terrors—of running a furnace during the

winter season. So "poor Papa" once more got busy and the automatic oil burner for warm air, hot water and steam furnaces was born.

The history of the automatic oil heater can properly be said to have begun in 1917. In 1916 Mr. M. J. Hammers, and Mr. C. L. Lewis organized the General Engineering Company for the purpose of producing "a positive and in the outset electrically ignited oil burner that would burn raw oil as against vaporized oil, which had theretofore been the prevailing type of burner in small units, and do it in a way that would be fully automatic." It was proposed that this type of burner be applied to three different lines of industry; (1) Power plants for trucks, tractors and other motor vehicles; (2) Power plants in relatively small units for use in connection with hoisting engines, stationary agricultural machinery, and the usual run of power plants to which the standard type of gasoline engine had been generally adopted; and, (3) The use of such units in the firing of household boilers and furnaces.

The first plant was put into successful operation in a motor vehicle in December, 1917. About this time the company was given an order for a most unusual design for a series of high powered steam tanks, so built and constructed as to be able to carry readily over the largest of the standard trenches in use then at the German front. In the following February the government inaugurated "Fuelless Mondays" and, while the company was building an essential for the Ordnance Department, none of the factories were allowed to use coal on these Mondays, even in munitions plants.

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The General Engineering was on a 24 hour day program and was most reluctant to discontinue operations for one day a week. It was therefore decided that now would be a good time to try out the heating capacity of these small power plants. First trying out the heaters in open spaces on concrete floors they were placed in two large sized sectional cast iron boilers. From that time there were some types of automatic oil burners in those boilers continuously. Thus the oil heating industry was born.

This was by no means the first time, however, that the use of oil in furnaces for heating purposes had been suggested. In 1890 or 1891 Raymond Greenwood was in the employ of the Atlantic Refining Company of Pennsylvania, being at that time stationed at Norristown, about eighteen miles out of Philadelphia. He devised a crude burner which he placed in a hot-air furnace, covering it with stones or broken fire bricks. Out in the back yard, a considerable distance from the house, he built a small tower in the top of which he installed a tank. From this tank he ran a pipe underground into the house and fed his burner by gravity with what was known as 88 gasoline, which volatilizes so easily that it has to be kept in metal drums. For several years he heated his house in this way.

Even prior to this—as far back as the 80's—barrels of oil had been put up on stilts in back yards in the oil field district of Western Pennsylvania and piped into offices, store buildings, etc., by means of a one-quarter-inch pipe, which in some cases led into ordinary stoves and in other cases hot air furnaces

where it dripped over surface brick after it had been manually kindled. None of these arrangements, however, were suited to produce positive, efficient and completely controlled automatic heat.

While the use of fuel oil in automatic burners installed in furnaces in private residences was first suggested in 1917, and although hundreds of oil burners were installed within the next two or three years, the oil-heating industry as a well organized going industry is actually little more than five years old. Yet within that time, automatic oil heaters have been installed and are operating successfully in hundreds of thousands of homes in the United States, while almost without exception new apartment houses and hotels are installing oil heating rather than the old-fashioned coal furnaces. During the past two years more than eighty-five thousand oil burners for private residences were sold by the industry, and there is every promise that the demand during the current future years will become even greater.

The story of this industry, is, from a business point of view, almost the same sort of fairy story as the story of radio. Both became great industries within a brief period of a few years. The social benefits of both cannot be measured in dollars and cents. Both are great contributors to the comforts of the private home. While there are six million radios in the United States as against approximately 350 thousand oil heaters, it must not be forgotten that a radio can be obtained for as little as a few dollars and also that a very large proportion of them are installed in apartments. Both

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encountered much of the same sort of grief in their early days, due to faulty equipment and poor installations, and both of them had to live down bad reputations due to "fly-by-night" manufacturers. Both blossomed out overnight as absolute successes and today both are devices which, once purchased, will never be given up by the purchaser.

Many of the early house-heating oil burners were crude affairs. They were noisy, worked spasmodically, and expensive to operate. Even today, the industry meets with a pronounced sales resistance, due to the record of those early days. Just as in the case of one phase of the automobile industry, a householder would purchase an oil heater only to find within a month or two that the manufacturer or dealer had gone into bankruptcy or for some other reason had ceased to manufacture and that he was the grief-stricken possessor of an "orphan." Hundreds of people went into the business of manufacturing oil heaters who knew nothing about the requirements of a heating system, and thousands of persons bought their product only to have them taken out and the old coal grates restored to their furnaces. As in the case of the first warm-air furnaces, these oil burners were manufactured and installed without any knowledge on the part of the manufacturer and installer as to what the systems were capable of doing or methods by which the best results could be obtained.

As a result, a body of adverse opinion on the part of the public, contractors, builders, and architects was built up which the industry is just beginning to overcome. Even today, while there are several

PROMETHEUS, U. S. A.

hundred manufacturers of oil burners of every conceivable type and at almost any price, there are only a small portion of them that have any real financial stability and that are installing equipment that has stood the test of time and proved its real worth.

It is for this reason that a number of manufacturers of oil burners have established what is known as the Oil Heating Institute. It was formed for the express purpose of establishing well-analyzed standards of design and service, and increasing the general knowledge of oil-burning equipment. It is an unincorporated organization founded to carry on research and educational work in this field. The definite standards which are stipulated in its qualifications for membership are:

1. Character and experience of management.
2. Financial vitality and responsibility.
3. An oil burner that has given satisfactory service over a minimum period of two years.
4. A minimum of 200 fully successful installations.
5. Listing as standard by the Underwriters.

The Institute also serves as a central bureau of information where anyone may secure unbiased facts and noncommercial advice on oil heat or the use of oil fuel. Working with the Institute are international authorities on oil and oil combustion, and specialists in the design of oil heating equipment. In this way the industry itself, at a considerable expense, has placed itself in a position where it can assure satisfaction to the public if that public purchase equipment which meets what it has definitely

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discovered to be the minimum requirements for satisfactory service.

The Oil Heating Institute is just one more example of a curious but highly interesting phenomenon in American industry. Here we have a group of manufacturers, all in the same line of business, each thinking that his product is just a little better than that of the others, all presumably competitors, getting together and literally pooling their interests, to say nothing of considerable sums of money, for what purpose? For the protection of the public against an inefficient product and unsatisfactory service. It is a consciousness that, in this particular instance, every time an unsatisfactory oil burner is installed in a home it is not only the individual manufacturer who is injured in reputation—it is the whole industry, the whole scheme of automatic heating by the use of oil fuel, that is injured. The consumer does not think in terms of the individual device. He thinks in terms of oil heating and condemns the whole business if his experience is unfortunate.

This gathering together of various individuals and representatives of corporations which go to make up industrial groups for the protection of the whole industry against inefficiency and lack of financial stability, which has been going on for years, is a healthy sign, the opponents of trade organizations and the Federal Trade Commission notwithstanding. In the first place it insures the public against inferior products, assuming that the public has intelligence enough to profit thereby. In the second place it presents the opportunity for collective presentation

[101]

of the story of the industry and in this way has a distinctive educational value. This collective institutional advertising, publicity or propaganda, if you will, can be done profitably on a national scale by a large number of manufacturers when it could not be done profitably by any single manufacturer. When competitors can get together and, forgetting the fact that they are competitors, establish minimum industrial standards, at the same time pooling their interests in an effort to tell their story to the public, that public is bound to be benefited.

A few years ago the automatic oil heater was considered by the general public as little more than an interesting experiment. But it must not be forgotten that it is only forty-five years since electricity for light and power was looked upon with skepticism by both investors and the general public, while twenty-five years ago we were still sneering at the automobile as a toy of the rich. In the summer of 1926, the manager of what is perhaps the greatest newspaper syndicate in the world told the author that there was no public interest and no news in aviation and refused to consider a series of stories which he proposed to write out of experiences on a three-weeks' airplane trip on which he was just starting as a government observer. That is only two years ago, and today aviation is on the front page practically every day. Only a few years have passed since the radio was laughed at and considered as an interesting laboratory experiment.

Today, the automatic heater is just as much a part of established American industry as the steam boiler for a steam-heating plant in the home, the

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electric or gas refrigerator, the various electrical appliances to be found in almost every home, the automobile, or, in fact, any one of the thousand and one conveniences which go to make our daily lives comfortable, healthy and pleasant. It has made its contribution to release from unnecessary drudgery and, after all, release from unnecessary drudgery is the one great accomplishment of modern civilization.

CHAPTER XI

The Battle of the Fuels

THAT the next ten years will witness a tremendous battle between various types of fuel for supremacy not only in the industrial world but in the home is generally admitted by the leaders in various fuel-furnishing agencies, though they discuss it with some reluctance. Today it is a three-cornered fight between fuel oil, manufactured gas, and coal. Wood can no longer be considered as fuel except in a few remote and scattered areas where neither coal, gas nor oil are, for the moment, available except at excessive cost. While there is much talk of electricity for heating and cooking, it must be remembered that the production of electricity depends to a great extent on the burning of some kind of fuel. Water power will never be able to supply but a small proportion of the energy necessary for our light and power needs and for the time being, at least, can hardly be expected to make any notable contribution to energy in the form of heat for cooking or house warming. Electricity generated by steam plants is making and will continue to make a constantly increasing contribution to the supply of heat for these purposes, but here again we must return to the consumption of some kind of fuel as the basis for this form of heat energy.

In contemplating this impending battle of the

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fuels—oil, gas, and coal—and its probable outcome, there are many things beyond the relative costs and the relative conveniences at the present time which must be taken into consideration. Reduction of the cost of living, comfort, health and convenience are, of course, matters of prime importance to the individual; but matters of national economics are also of prime importance, although not so easy to discuss in concrete form. For example, the destruction of one great industry because of the manifest superiority of two or more other industries is a serious matter and always calls for adjustment of labor conditions, capital and national income. Unless the labor, the capital and the equipment which is employed in that industry can be employed in some other way, the whole industrial fabric is affected and hardship to a very considerable number of people is the inevitable result.

There is also the matter of the future ability of the industry or industries to take care of a greatly increased business due to the failure or elimination of some competing industry. There is such a thing as too rapid an increase in the demand on any enterprise. Supplying the demand for fuel depends entirely on ability to distribute. The petroleum industry depends on its pipe lines, on the railroads and on the public highways over which its tank wagons and motor trucks travel. The gas industry depends on its gas mains and on the railroads which bring to it the coal necessary for the manufacture of gas. The coal industry depends on the railroads and on the public highways. Each industry can supply to its present and future customers only the amount of

fuel which it can distribute through these agencies. Any sudden and heavy increase in demand for any type of fuel means a sudden and heavy demand on the distributing facilities. This in turn means enormous additional capital requirements which, together with such other readjustments as may be involved, can easily result in an additional cost to the consumer instead of the reduced cost which usually accompanies increased production and sales.

In so far as the individual householder is concerned—and, after all, this book is a book on fuel and the individual—coal as direct fuel is passing rapidly from the picture. This does not mean that the coal industry is becoming a thing of the past nor does it even mean that the coal industry is facing a serious depression, although it may mean a period of readjustment which will result in some temporary depression. On the contrary, it may be the best thing which could happen to what has sometimes been called the “bad boy” of the industrial family. If this forced readjustment will put the organization of the coal industry on some sort of a sound economic basis comparable with other industries, nothing better could happen for the mine operators, the miners and the nation at large.

In the first place, the burning of coal as raw fuel is wasteful, and anything which is wasteful is bad economic practice. Experts estimate that of every ton of coal mined in America at the present time, no more than 100 pounds of the fuel value of the coal is converted into mechanical energy. This means that every time 2,000 pounds of coal is mined, hoisted to the surface and used as direct

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fuel, 1,900 pounds, or 95 per cent, is wasted so far as effective work is concerned.¹

Burning raw coal is unscientific. We have seen in a previous chapter how coal should be considered as the raw material from which many useful products are made. If, for example, it is used in the manufacture of gas, it will produce 1,400 pounds of coke (a smokeless fuel), 10,000 cubic feet of gas, 25 pounds of ammonium sulphate, one and a half gallons of benzol, and ten gallons of tar. This is, perhaps, the principal reason why the passing of coal as a household fuel will not affect the future of the coal industry in any way except along the lines of a general improvement in conditions for every single person concerned with it. The coal formerly burned in the home furnace will be used as a raw material for the manufacture of innumerable valuable products, and the industry will have taken a long step forward toward getting on an all-year-round basis instead of remaining on a seasonable basis, a situation to be devoutly prayed for.

Coal as fuel for house heating and cooking is wasteful of transportation facilities. The situation is somewhat analogous to the situation in the commercial fertilizer industry. For years the manufacturers of fertilizers have been endeavoring to educate their customers in the use of concentrates and persuade them of the economies to be obtained by doing their own mixing. For one reason or another the farmers have refused to be educated in this regard. As a result, the major portion of every ton of fertilizer is plain dirt, the transportation of

¹ *Gas, Manufactured and Natural.*

which is a complete and absolute waste. In the same way, every ton of anthracite coal which is shipped contains about 200 pounds of ashes and every ton of bituminous coal which is shipped contains about 275 pounds of ashes. The farmer who buys a ton of fertilizer may have to pay transportation on dirt, but at least he can use the dirt on his farm. The householder who buys a ton of coal and pays transportation on ashes has no earthly use for these ashes. He must even pay to have them taken out of his cellar and hauled away.

The burning of coal means smoke, and smoke pollutes the atmosphere, injures the health, and destroys property. It is claimed that more persons are devitalized, disabled and poisoned by the impurities in smoke-polluted air than by noxious ingredients in food or water. Density of atmospheric smoke increases pneumonia and causes other illnesses. All smoke diminishes sunlight, increases the humidity during cold and warm weather and must exert an important influence upon the health of all persons who live in a smoky city.¹

Health Commissioner Harris and the Merchants Association of New York City have estimated that smoke costs the merchants of that city no less than 100 million dollars a year. The Mellon Institute estimates that the annual smoke loss and damage in Pittsburgh is 10 million dollars, or almost as much as the city's annual bill for domestic fuel. As Chicago has nearly five times the population of Pittsburgh, it is conservative to put the annual cost of smoke damage in that city at 20 million dollars, or

¹ *Gas, Manufactured and Natural.*

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nearly double that of Pittsburgh. The total volume of air-diluted gases discharged from smokestacks in Chicago each day amounts to approximately 47 billion cubic feet, or 58 times as much as the average daily consumption of manufactured gas.

During the year 1926 no less than thirteen tons of soot was taken from the roof of the Art Institute in Chicago which, during 1927, was reduced to four tons. According to the superintendent, the volume of smoke and cinders falling on the roof seeping into the building and defacing costly paintings, statues and fabrics was greatly reduced because of the electrification of the Illinois Central Railroad. "We have been able to cut down on our staff of custodians," he says, "and the work of preserving the objects of art has become less of a problem. The soot and smoke form a thin coating on everything it comes in contact with and is bound to result in disintegration. The reduction of the evil of smoke pollution is of great value to the Art Institute."

Completely overshadowing questions of economics, elimination waste, and even abstract questions of health, there is, in the mind of the average householder, the question of convenience, comfort, and the elimination of drudgery in his daily life. In an official statement, the United States Bureau of the Census said: "Automatic heating completely does away with the most disagreeable task in the home and lightens the very housework for which scores of other modern devices are bought. Less dishwashing need be done and less ironing. The hum of the vacuum cleaner is heard less often. The drudgery of a lifetime of housework doesn't com-

pare with one season's labor of tending a furnace. The greatest advance in home comfort has been the step from the old furnace to the new automatic heat."

The elimination of drudgery is the outstanding characteristic accompanying the passing of coal as a household fuel and the coming of automatic heat. The householder does not live, even though he may employ a furnace man to come morning and evening, who does not view his coal-burning furnace with a malevolent eye as an arch enemy taking away from him his constitutional right of life, liberty and the pursuit of happiness. In severe weather, the furnace demands attention during the day. The average servant, temperamental as a prima donna, considers that she is hired to cook or do the general housework and not to shovel coal. The result is that the mistress of the house more often than not must turn the furnace on and off and see that it receives its innumerable meals of solid fuel during the day, which does not always contribute to her good humor when the alleged master returns home at night. Seriously, the conservation of woman power and her release from the greatest drudgery of her household tasks is one of the great contributions to comfort made by automatic heat.

Coal burning in the home means that a considerable portion of the cellar must be given over to coal storage space. This stored coal, combined with the ashes which result from its burning, means that the rest of the cellar is usually in such a condition of uncleanness that it is of little value except for storage. The ashes must be removed at frequent inter-

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vals, which means more dirt and more drudgery. In fact, there is not one single good thing which can be said about coal either from a standpoint of economics or from the standpoint of social welfare, except that it will keep a house warm; but for that matter so will wood if one burns enough of it, and we laugh today at the idea of heating our houses with wood except as we may burn it in an open fireplace, not so much for heat as for the atmosphere of good cheer which an open fire imparts to a living room.

And so we may safely assume that the battle of the fuels will, sooner or later, be reduced to two adversaries instead of three in so far as the home, the apartment house, the hotel and the office building are concerned. These are fuel oil and manufactured gas—the only two fuels which will supply automatic heat. Sooner or later the forces of coal will fold their tents and quietly steal away, leaving these two industrial giants to fight it out between themselves. In so far as gas is concerned, coal will continue to be an important factor in house heating, as it is used in the manufacture of gas. As a direct fuel, however, it is traipsing along the path taken so long ago by wood.

In so far as convenience is concerned, there is little difference between gas and oil as domestic fuel. Both furnish automatic heat. Both eliminate coal and the drudgery of a coal-burning furnace. Both require little or no attention from the householder or his wife. Both eliminate the necessity for storage space in the cellar as well as the dirt and smoke which accompanies the burning of coal as a direct fuel. Both are products of industries which are stable,

financially sound and which can assure the home owner, concerned with a considerable investment in his heating plant, of permanency.

There are, however, certain factors in connection with each type of fuel which must be examined if one is to get any accurate picture of what may be called the "battle of the fuels." In the following chapter, the question of costs will be discussed; in this chapter, we are only concerned with those things which affect the future of both industries, regardless of cost to the ultimate consumer, at the present moment. The question of costs ten years from now is more important than comparative costs today.

Let us suppose that oil and coal should suddenly be eliminated as household fuels but that the gas manufacturing industry could still obtain plenty of coal for gas-making purposes. What would the gas companies do toward taking care of this tremendous additional domestic load?

It has been estimated, that the present gas mains and gas-making equipment throughout the United States could take care of but two per cent of the total domestic house-heating load if the gas companies should suddenly be offered all the business in the United States. In other words, present-day equipment can handle but two per cent of the domestic requirements for heating. This does not mean that there are no gas companies in the United States with sufficient distribution facilities to take care of more than two per cent of the domestic load for house heating. In Baltimore, for example, the gas company is taking care of more than five per cent of the house heating in certain neighborhoods without

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placing any undue burden on the mains. We are considering the house-heating requirements and the present gas distributing facilities for the entire United States.

Here again we meet our old friend, Distribution. It might be a comparatively simple matter to increase the gas-making equipment with sufficient rapidity to take care of a rapidly increasing demand. But to increase the distributing equipment is quite a different matter. Gas is in exactly the same position as electricity. Its production is a very small item in its total cost to the consumer. If electricity could be produced for nothing, it would make little difference in the monthly bill of the average householder. If gas could be manufactured for nothing—if the cost of the coal and the cost of getting 10,000 cubic feet of gas out of each ton of coal could be eliminated—there would still be the tremendous cost of the capital investment in the gas mains, in meters, and in a variety of overhead and operating items such as depreciation, amortization, bookkeeping, collections, bad accounts, taxes, selling, and so on and so forth *ad infinitum*. A kilowatt of electricity may cost only 3 or 4 mills to generate, but it costs 7 or 8 cents by the time it is delivered to the consumer. And the greatest item in this cost which lies in that twilight zone between the cost at the plant and the cost at the individual meter is the cost of distribution.

It is quite evident that any tremendous increase in the domestic demand means only one thing—a bigger distributing system, whether it be in the form of bigger mains or in the form of mains which will stand greater pressures. This means a rebuilding of

the entire system. Streets must be torn up, new mains, and in many instances new feed pipes into the individual houses laid, and the charging off of the investment in the existing system. All of this means that the capital which the individual gas company has invested in its service will be tremendously increased, and capital is quite as insistent in its demand for wages as human workers. Interest must be paid on past capital invested as well as on the new capital which is put to work to supply this new demand. All of which operates against the future of gas as the outstanding heating fuel unless there is no other fuel which will give this boon of automatic heat. In other words, greatly increased volume of business will not have a tendency to reduce unit costs; on the contrary, it may easily have a tendency to increase them.

Fortunately for the oil industry, the distribution of oil fuel faces no such problem, for distribution is made above the surface—by tank wagons. No matter how fast the demand increases, the only requirement is additional tank wagons. The increase in equipment can be just as gradual as the increase in demand.

Another factor in the distribution problem is the question of seasonal loads. Fuel for heating is required only in the winter months. The gas company supplying a great quantity of gas for heating must have a maximum amount of equipment to supply the demand in the coldest months. In the summer months there is no such demand and a large portion of the distributing and the manufacturing equipment will be idle. On the other hand, the oil com-

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pany has the possibility of taking its tank wagons with which it has distributed oil during the winter months and with very little trouble take the tanks off, put on some other kind of bodies, and use this equipment as motor trucks for the hauling of building materials and various other purposes; or, in many cases, tank wagons which are used for the distribution of fuel oil in the winter months can be used for the distribution of gasoline during the summer months.

In other words, the distributing equipment of the oil company can be kept in use all the year round, while the distributing equipment of the gas company having a heavy winter domestic heating load must necessarily be idle during a considerable portion of the year. All of this must have its effect on the future relative costs of oil and gas for fuel in the home. And it is future supplies and their cost with which the home owner should be primarily concerned.

On the other hand, the gas manufacturing industry has been quick to recognize this problem of seasonal load and to appreciate that if it hopes to become an important factor in house heating it must turn, as all industry must turn sooner or later, to fundamental research and find ways and means of taking up the slack. Already gas refrigeration has become a notable competition of electric refrigeration and is making rapid strides. This, however, will never solve the problem. The amount of gas used in operating a gas refrigerator is small and hardly comparable with the amount of gas used by a gas-burning heating plant in the basement. The industry, it would

seem, will have to devise other methods of gas utilization during the warmer months if it is to avoid the heavy burden of idle or partially used equipment during a considerable portion of the year.

Manufactured gas has a distinct advantage in that it can come to the house through a main, just as it comes for the gas range in the kitchen, as the electricity for the electric lights and the household appliances comes over the wires, or as the water comes through the water mains. All the consumer has to do is turn a tap and pay his bills once a month. The same thing is largely true with oil. The tank wagon fills the tank buried in the ground outside the house once a month or once in three months, as the case may be. The consumer pays his bill and that is all there is to it. The only difference is that in the one case the tank holding the fuel is a great central tank and in the other it is an individual tank.

The foregoing paragraphs deal simply with the various factors which will affect the future of gas and oil as the outstanding fuels for household use. Both supply automatic heat with equal efficiency and both eliminate the disagreeable features which attend the use of coal. What will be the fuel of the future is something which seems to the author to be quite without the province of this book. Certain it is that whatever it is, it will be a fuel which will deliver to man a clean, healthful heat, when he wants it, as he wants, and without concern on his part. In the battle of the fuels the victor must solve these basic problems of supply and demand.

In industry, automatic heat, whether it be by gas or oil, has many advantages over coal. Most of

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these are set forth in another chapter and both apply equally well to gas and oil. Perhaps the greatest of these is the release of a large amount of labor for other purposes and stability, evenness and continuity of heat applied. There is no necessity to supply storage space except, as in the case of oil, tanks buried in the ground. Ashes, ash storage and ash handling are all eliminated. As there is complete combustion when gas or oil are used, there is also no question of smoke. While neither oil nor gas nor both will ever entirely supplant coal as fuel in industry, both have already become serious competitors of the solid fuel. In some districts, it is cheaper to generate electricity with oil-burning steam plants than it is to generate it with coal or gas-burning steam plants, and, as in the case of California, cheaper even than the generation of electricity by hydro-electric plants.

CHAPTER XII

What Price Heat

WHEN Mr. Average American Citizen goes in to buy an automobile, the thought which he has in his mind is: "How much can I get for my automobile dollar?" He may not express it in that way to himself, but what he is really after is just as much automobile as he can buy for the amount of money he has to spend. He is in what the industry calls a certain "price class." The maximum amount which he can spend may be a thousand dollars, but he hopes to get a car which he likes for less. Or, perhaps, he can spend anywhere from a thousand dollars to fifteen hundred dollars. Or he may be able to afford a two-thousand-dollar car. Or, being extremely well-to-do, price may not enter into his consideration. The point is that he does not think in terms of "cheapness." He has no idea, and has never thought of the idea, of buying a car because it is "cheap." All he wants is all the car he can get for the money he can afford to spend for a car, whether he buys it outright or on the installment plan. He wants all he can get for his "automobile dollar."

If this "prospect" finds two cars of approximately the same price, does he think in terms of operating expenses? Is the conclusive argument of this or that salesman the statement that one of the two cars will do two or three miles more to the gallon of gasoline

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than the other? Does he think in terms of repairs? He does not. He looks the two cars over and makes his decision because he thinks one of the two cars is more automobile than the other. He may like the design of the motor meter, or the appearance of the dash and the instruments on the dash, or the lines, or the upholstery of the one better than the other.

The point is he does not think in terms of "cheapness." He has just so much money to spend and he wants what in his opinion is the most car he can get for that sum. He does not compare a Cadillac with a Chevrolet. He does not compare a Lincoln with a Ford. He does not compare an eight-cylinder engine with one which has only four cylinders, and he would laugh if you suggested such a thing to him. He knows perfectly well that you cannot buy a Rolls-Royce for the price of a one-ton delivery wagon and he has no intention of making any such effort. The average purchaser of an automobile is a first-class economist because he does not think in terms of the bargain hunter; he thinks only of dollar values—what can I get for my money and what will it be worth to me in comparison with the investment?

In the same way, the average home owner, thinking of his heating plant in the cellar, should not think in terms of cheapness. If he goes out to buy a plant which is the cheapest thing on the market, he is only laying up a lot of grief for himself. If he stops to think of the cost of operation, the chances are that while he may keep his house warm he will do so at the cost of much greater effort and much more inconvenience to himself than his neighbor who thought in terms of a six-cylinder plant rather

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than in terms of the four-cylinder delivery wagon because it was "cheaper."

In comparing the various types of heating equipment which one may acquire for the purposes of keeping warm, it is easy to fall into the error of comparing a six-cylinder 1928 model automobile with a four-cylinder 1914 second-hand runabout. Questions of initial costs and operating expenses are all very well in their place; but comfort, convenience, health, and the elimination of drudgery are much more important, providing, of course, that these things do not cost so much more that they are prohibitive. If they cost approximately the same amount, then so much the better; the purchaser is in exactly the same position as the man studying two automobiles of approximately the same price. Which one, in his opinion, gives him the most in the way of satisfaction, for his dollar?

Therefore, in any consideration of heating equipment, the all-important question is *the service* which will be given by this or that plant rather than the question of the "cheapness" of this or that plant. What does it mean to the householder and the comfort in his home? Enough has been said about this in the last chapter to make any further discussion almost unnecessary and enough more could be said to fill two books the size of this one. Automatic heat in the home is a six-cylinder car in the garage. Automatic heat, which can only be provided by equipment using oil or gas, is so superior to coal-burning furnaces that there seems to be little room left for argument. The only question is, does automatic heat cost so much more than coal heat

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that its cost is prohibitive for the average citizen. Let us see.

The initial cost of automatic heat is, of course, greater than the initial cost of a coal-burning furnace. The man who already has his heating plant installed must make a considerable additional investment to transform his plant into one which is automatic. The man installing a heating plant in a new house must invest a considerable amount in addition to the amount he would invest in a coal-burning furnace. There is no use in trying to dodge that fact. At the same time, it is well to remember that an electric refrigerator costs a lot more than an old-fashioned ice box; a vacuum cleaner costs more than a carpet sweeper, and an electric sewing machine costs more than one which the wife and mother has to pump with her two feet. The question is, does the electric refrigerator, the vacuum cleaner or the electric sewing machine give greater and more comfortable service than the old-fashioned devices of a passing generation? In other words, are they worth the money? It is not a question of cheapness—it is a question of dollar values in service rendered.

In other words, we are not faced with the question of justifying the cost of automatic heat or, in fact, the cost, of any other modern appliance. We may admit however that possibly we are faced with the question of justifying the cost of progress—progress and civilization presuppose payment for the thing that is new because it is better than the thing which preceded it, and then going on to something that is newer still. If we are not willing to pay

or if we cannot pay, then we may expect that man will sooner or later revert to the time when he took but two baths: the first immediately after birth and the second immediately after he had taken his departure on that long, long trail from which no traveler has been known to return.

And so this book does not propose to narrow itself down to any superficial discussion of costs. It is a history of heating from the days of Prometheus to the day of automatic heat. Legend has it that fortunately for mankind Prometheus did not balk at the price he had to pay for his gift to man. He was quite willing to be chained to the rocks as a symbol of the cost of progress. Again, fortunately for mankind, man has never considered the cost of pain and transition when something new and demonstrably better has loomed on the horizon.

To whom should go the credit for the automobile of today? To the General Motors Corporation or to Henry Ford or to any or all of that gallant company of manufacturers that go to make up the National Automobile Chamber of Commerce? Not at all. Great credit is due them, but a still greater credit should be granted those early pioneers who, with faith in their dreams, invested their all in this new and untried device and lost, gathered together more money and again lost, until finally the automobile became a practical means of transportation far more flexible and far better for many purposes than any form of transportation we had hitherto known.

To whom should go the credit of the airplane of today which has taken such a firm hold on the imag-

ination of the American people and which occupies so much space in our daily papers? To the bankers who are now investing untold sums in airplane manufacture and in air transportation enterprises? Not at all. Great credit is due them, but far greater credit is due those pioneers who invested their all in this seemingly absurd idea of a heavier-than-air device which would fly, and to that vast army of early pilots who cheerfully risked and more often gave their lives that the science of aviation might go marching steadily onward.

The whole history of progress in any line of human endeavor starts first with ingenious individuals followed by the support of experimenting millions ever ready to put one step forward ahead of their fathers. Without this healthful attitude of refusing to count the cost there can be no progress; and civilization, instead of marching ever onward, would sound a retreat if, indeed, it would have ever moved forward. And does the commonplace individual to-day who is engaged only in acquiring a comfortable living and as many luxuries as possible for his family count the cost? Does he stop to say to himself: "Can I afford a radio, or can I afford an automobile, or can I afford any of these new and ingenious appliances which go to make the daily life of the household more comfortable and pleasant?" He does not. He makes up his mind that in one way or another he can afford that which he wants, and having reached that state of mind he proceeds to acquire these new things so much better than the old without having, in the first instance, counted the cost.

Turning back to the question of automatic heat

and passing the question of initial cost which is a hard and fast item from which there is no escape, is the cost of its operation prohibitive when compared with a coal-burning furnace? Here again we may fall into the error of comparing only the cost of a season's supply of fuel; but even if we do this statistics go to show that automatic heat is cheaper than coal and that in most instances automatic heat with oil fuel is cheaper than with gas. If we take any given section of the country and compare the cost of a ton of coal with the cost of an amount of oil fuel required to give the same amount of heat or the cost of the amount of gas required for the same purpose, we will find that coal is the most expensive, fuel oil the least expensive, with manufactured gas somewhere in between. Of course in those areas so fortunate as to be supplied with natural gas this form of fuel is by far the cheapest. The author has before him figures on the cost of various types of fuel in a number of large cities scattered throughout the country, and all of them tend to prove definitely the accuracy of these statements.

This is by no means the whole story. Costs, in the operation of a home heating plant, are not confined to the cost of the fuel. If one burns coal, there is the cost of a furnace man, if one is so fortunate as to be able to afford a furnace man. There is the cost of removing the ashes. There is the wear and tear of rugs, hangings, and other furnishings, to say nothing of the cost of the wear and tear on one's nervous system. There is also an intangible cost involved in the question of health. Automatic heat provides an even temperature which need not vary

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more than a degree or two, regardless of the changes in temperature outside the house. This one feature alone more than counterbalances any excess cost if there should be an excess cost—which there is not.

But the average householder should not concern himself entirely with the cost of operation today. What is his heating equipment going to cost him five, ten or fifteen years from now? Here once more we enter into the whole question of the fuel of the future which was discussed at length in the previous chapter. If he changes from coal to automatic heat, he wants to know whether or not the cost of operating his new equipment is at some time going to be prohibitive. If, for example, he knew that within two years gasoline would cost 75 cents a gallon, he would, in buying an automobile, consider first and last the mileage which he could get out of a gallon of gasoline. In the same way, he must consider what the fuel with which he must run his furnace is going to cost two years from now. What is the situation with regard to the industry furnishing that fuel, and will it be able to keep its price within the range of present prices? Again there arises the question "Fuel oil or gas?"

Naturally, the fire hazard enters into the question of cost. Any considerable reduction in fire losses eventually means a reduction in fire insurance premiums. Fire is waste and the elimination of waste means additional national income benefitting everybody. If oil heating reduces the fire hazard (and the experts say that it does), then surely this fact must be taken into consideration in

any discussion of costs. Furthermore, there is the additional value added to properties equipped with automatic heat. This is also an established fact. When a householder puts in an oil heater, he has invested in something that has added to the cost of his property to him, but he has also added to the value of that property by just that much, as his banker will promptly tell him if his banker has given the slightest thought to the question and is not too remote from a railroad.

CHAPTER XIII

The Perfect Servant

ACCORDING to archeologists, the upper-class Roman homes during the reign of the Cæsars were the first houses to be heated by furnaces. Beneath the floor of these Roman villas low, arched vaults were built. This was the furnace, the stone or brick vault being the fire box, while passageways inside the walls were the pipes for hot air and smoke; it was called the "Hypocaust" or "basement fire room." When the mistress of the house decided "*Frigida sum*" (I'm cold) she drew her garments about her and tapped sharply on the wall with a mallet. In a short time a rumbling came from beneath the marble flooring. A moment later a puff of smoke trailed out through a crevice in the wall. The noise and the smoke told her that the furnace had been attended to and that in a little while the room would be warm. These Hypocausts disappeared with the fall of Rome, man returning to the more primitive method of building fires upon the floor of his dwellings until about the fourteenth century when fire-places first appeared.

Since time immemorial man has been greatly concerned with the problem of pushing the ugly machinery of life into the background. In the "pre-machine" days this was accomplished in the homes of the wealthy, as far as possible, by slaves or

servants as the case might be. The perfect servant was the one who, always at his master's elbow but in the background, made it his business in life to anticipate that master's every wish. His success in his profession of "perfect servant" depended upon his ability to meet the requirements of the day almost before his master was conscious of them as requirements. If warmth was required the fire was lit by the servant or slave and the room warm before the necessity for warmth was apparent. The well-to-do were rarely, if ever, conscious of the things which had to be done to accomplish this warmth.

In the case of the Hypocaust, the Roman mistress of the home was always conscious of an item of what we may call the "ugly" machinery of life, even though she possessed innumerable slaves to do her bidding. First she was cold and had to communicate that fact to the slaves in the basement. Having done this, the next bit of evidence was a rumbling noise followed by smoke curling into the room. True, she accomplished warmth but only after some effort and considerable discomfort. The same thing was true of the primitive fire built on the floor of the dwelling with the smoke curling out of a hole in the roof, and also—but to a lesser degree—of the open fireplace which, as we have seen, was followed by the stove in the center of the room. The same thing is true of the coal-burning furnace in the basement today. Unless one is so fortunate as to possess the perfect furnace man (his existence is more than doubtful) or some other kind of a perfect servant, there are innumerable disagreeable tasks in connec-



THE PILGRIMS TRIED TO WARM THEIR STURDY LOG HOUSES WITH FIREPLACES

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tion with keeping warm. Drafts must be opened or closed, coal must be shoveled, the furnace must be shaken down morning and night, the ashes must be removed, and with it all there are always periods when the house is uncomfortably cold or uncomfortably warm. The householder and his wife are always conscious of one of the ugliest pieces of the domestic machine.

All man wants of heat is warmth without knowing where it comes from. Just as long as man was having continually thrust upon his consciousness the things which had to be done and the effort which he had to make to accomplish warmth in his home, he was having thrust upon him some item of the ugly machinery of life. It makes no difference whether it was the open fireplace, the Franklin stove in the room or the modern coal-burning central plant in the cellar which provides hot air, hot water, or steam heat, it has always required a certain amount of effort and labor to keep the room or the house warm. Any change in temperature has meant work and very often unpleasant work and also delay in bringing the room or the house back to the temperature required for comfort.

With the coming of automatic heat, the thermostat on the wall has taken the place of the hypothetical perfect servant. The oil heater which fulfills its destiny is the one about which, when its possessor is asked how he likes his oil heating plant, he replies: "I don't know. I haven't been in my basement in six months and I never see it." Here we have the acquisition of one of the greatest comforts of life without having the machinery with which it

is accomplished constantly before us. The desired temperature without variation regardless of changes in the weather outside. Warmth before there is any realization of the need of warmth.

American industry has given us new standards of living to talk about. Light, fuel in the form of gas for cooking, transportation and communications have all contributed to these standards until they have become the wonder of the whole world. Yet nothing has made a greater contribution to our daily comfort than the automatic heat and it is all because we obtain warmth without any realization other than that we are comfortable. Even though we may think of electric lights and of gas in terms of service, there still remains some little effort on the part of the individual. In the case of transportation, whether it be by automobile, street car, railroad train or airplane, one must always do something and the machinery with which the transportation is accomplished is always evident.

With automatic heat this is not the case. It is probably more analogous to the instantaneous hot-water heater than anything else. With the instantaneous hot-water heater, the householder soon forgets all about his hot-water needs. It is always there when he needs it and he is no longer conscious of it. So it is with the oil burner. It is always there, functioning automatically with each slightest variation in temperature, and the average householder soon forgets all about it, realizing only that his home is warm without effort or thought on his part. It is giving him something which he wants at the exact

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time he wants it and before the need of that something is felt.

The picture of the automatic-heating industry as a great public service enterprise contributing immeasurably to the comfort of our daily lives is, therefore, a much finer picture than that of an industry in terms of so many thousand ingenious mechanical devices of varying degrees of efficiency, of costs, and sales, and distribution, and what not. It is significant of the times that the American people are willing to pay and can afford to pay for comfort, for the elimination of drudgery and for higher standards of living. A higher standard of living is the elimination of drudgery and makes for social, economic and intellectual progress. Present the automatic oil heater in these terms of service, and cost immediately becomes a secondary consideration.

If this is correct, then the oil-heating industry is decidedly something more than a mere aggregation of manufacturing plants engaged in making and selling heating devices. It is a public service enterprise and must concern itself with all of the phases of public service. The device itself is more or less incidental to that service, and if it is going to continue to sell devices it must visualize itself as a heating service—a service which furnishes warmth without thrusting the machinery on the consumer who desires that warmth. When it installs its device in the basement its work has just begun. Not only must that device be kept in a high state of efficiency but the oil-heating industry must be concerned with the efficiency of the collateral services; the electric cur-

rent necessary to operate the device and the fuel oil supply service supplying the fuel that, by means of the device, furnishes the warmth. To reach the highest state of efficiency the oil-heating industry must, in the very nature of things, cooperate closely with the petroleum and power industries. After all, it is these three, acting in concert, that supply man with this perfect mechanical servant which always anticipates his wishes.

But there are many other things of social significance which are accomplished by automatic heat aside from this question of pushing into the background another piece of the ugly machinery of life. The growing popularity of apartment house life is due, to a considerable extent, to the dread of the furnace in the basement. No one who has ever tried it will deny that the private house provides a far more satisfactory home life, particularly when there are children, than the apartment which at best always has something of the atmosphere of a hotel and which almost always lacks the comfort of spaciousness to be found in even the most humble of dwellings. But the householder who cannot afford a servant or servants to do things for him is a slave to his heating machinery many months of the year unless he is so fortunate as to have automatic heat. He cannot even leave his house for a week-end without turning off the water and draining the water from his hot-water or steam plant for fear of freezing. When he returns he returns to a cold, damp house and must go to work at once cleaning out the fire box, filling the boiler and building a fresh fire. It is a form of disagreeable drudgery from which people

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shrink, the boom in apartment house building, not only in the cities but in the suburbs, being the inevitable result.

With the coming of automatic heat all this is changed. The heating plant which is tended by that perfect servant, the thermostat on the wall, together with such other labor-saving devices as the electric refrigerator, the vacuum cleaner, the washing machine and the dish washer has simplified life in the private home to such an extent that it is quite as free from drudgery as the apartment or even hotel rooms.

Anything which relieves the women of the nation of any portion of the drudgery which accompanies all housekeeping and gives them more time to attend to their children, to take part in activities which add to the culture of the people as a whole, or which gives them an opportunity for self-improvement and amusement, must be of the greatest social and economic value to the nation as a whole. It is an improvement in the standard of living and makes for progress in every direction. In literally millions of homes where the family prefers to bear the drudgery of a coal-burning furnace, the mistress of the house must tend the fire during the day just as the women of primitive tribes were called upon to tend the home or community fires. It is the most disagreeable task in her multitude of household duties and is one which at no time can be neglected. Its elimination is just one more contribution to the conservation of woman power, the importance of which is not denied by any thinking person.

With the passing of the coal furnace comes the

passing of the ash man and the furnace man. Without doubt there are literally tens of thousands of men throughout the United States whose chief vocation is the tending of furnaces and the disposal of ashes. This is a form of labor which is eliminated with the coming of automatic heat, thus releasing it for other and far better purposes. Any labor-saving device is a contribution to national income for it adds to the sum total of human effort which can be called upon, and labor is just as much of a national asset as raw materials.

The question of health is another important factor which is making its contribution to the elimination of the coal-burning furnace and its substitution with automatic heat. A prominent physician has said that, contrary to traditional belief, most people catch "hot" instead of catching "cold." Certain it is that we are most susceptible to disease germs when we have been subject to the stuffy atmosphere of overheated rooms or to changes of temperature for which we are not prepared. This is particularly true when there are children in the household. The best evidence of the fact that automatic heat creates living conditions beneficial to health is that the new large dormitory for girls at Devitts Camp Tuberculosis Sanatorium is oil-heated. In winning the fight against the great white plague, unfailing, easily controlled, uniform heat is next in importance only to clean, fresh mountain air and sunlight.

There are many other benefits to be derived from automatic heat. There is the elimination of the dangers from coal gas—a real danger as the daily papers, recounting the many tragedies during the

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course of the year because of coal gas, tell us. There is the elimination of the fire hazard which is now recognized by insurance experts. As told in a previous chapter, Mr. John Gambier, past president of the National State Fire Marshals' Association, has said: "In fact, a credit on insurance premiums should be allowed owners of oil burners. With more widespread use, they are rapidly becoming an important protection that is certain to reduce fire losses in the country." Nothing makes such inroads on national wealth as destructive fires, and anything which prevents them eliminates this waste and adds to national wealth.

One often hears, when automatic heat is being discussed, the question, "What is to become of the retail coal dealer?" The answer seems simple enough; he becomes a dealer in fuel. He is the logical man to handle oil fuel. He has his reputation in the community. Over a long period of time he has built up a trade in household fuel. His customers have learned to depend on him to supply them with fuel when they need it. He, on the other hand, knows their needs, their ability to pay, and how best to please them. Furthermore, there is money for the coal dealer in handling fuel oil. He will have less overhead, less labor to employ, the fuel will be cleaner to handle—and hundreds of dealers all over the country are actually handling both coal and oil with profit, agreeing to supply their customers with fuel no matter what that fuel may be,—oil, wood, coal or coke.

And so we see that this perfect servant—this little device on the wall controlling noiseless, efficient

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machinery in the basement for the production of warmth so different from the old Roman Hypocausts—has created no social or economic problem but, on the contrary, has solved many of them. It is just one more of the benefits conferred on mankind by the machine age; something which shoves a part of the ugly machinery of life into the background.

CHAPTER XIV

Petroleum and Industry

WHILE the enormous demand for gasoline made on the oil industry by the automobile is largely responsible for the intensive production of crude oil today, it must not be forgotten that petroleum, coupled with the rapid progress in refining methods, has made the automotive industry. Without a plentiful and cheap supply of high-grade gasoline, the pleasure car would still be an expensive luxury instead of being in the category of necessary commodities. Colonel Drake and his first drilled well, the modern oil refinery, the internal combustion engine, and mass production brought about by cheap power, all have shared in bringing the motor vehicle within the range of almost every pocketbook.

Like many other things which we seem to think are peculiarly products of our times, the idea of an internal combustion engine is not new. In 1799, a Frenchman by the name of LeBon invented an engine that worked on the principle of a cannon, the cylinder of which was like the barrel of a gun and the piston like a cannon ball. Instead of gunpowder, street lighting gas was exploded in the cylinder. This drove the piston toward the end of the cylinder where it was fastened so that it could not be completely driven out but had to return. Simple as this may sound, it is the same identical principle as is

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used in automobile engines today. This is why they are known as explosion or internal combustion engines.

The first man in America to make a successful internal combustion automobile engine was Charles E. Duryea. In 1891 he started to build a gasoline carriage and by 1894 he had built five. The fifth one had many of the features of our modern automobile, such as a four-cycle engine, electric ignition, a rigid front axle, the present type of steering gear and pneumatic tires. With this car he won a road race for a prize offered by a Chicago newspaper, his average speed being ten miles an hour.

Today, just thirty-three years later, there are about 23 million internal combustion engines rushing motor vehicles about the public highways. The average individual has been released from transportation systems which, because of their characteristics, must operate on fixed schedules. Before we had these motor vehicles, we were dependent on horses both in the country and in the city, upon street cars in the city and upon the steam railroad to get from one city to another. Now we carry our transportation with us and are, so to speak, our own train dispatchers.

We spend for motor vehicles each year more than enough money to run all the public schools in the United States; enough, in fact, to buy all the farms in Virginia and West Virginia with the houses and outbuildings on them and still leave half a billion dollars for operating expenses. We pay automobile manufacturers annually enough to support one million families of five persons each in comfort, to

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pay the rent on two million comfortable houses, or to buy 250 thousand houses at \$7,500 each, and 250 thousand houses make a great city. The two billion dollars we spend each year for automobiles is a great deal of money.

All of this has been made possible by cheap fuel—fuel recovered from petroleum by the oil industry. True, cheap power has made a great contribution by making possible mass production; but without cheap fuel with which to operate these automobiles, the American public could not afford to maintain them in any such quantities. The truth of this is shown by the situation in other countries. Visitors from Europe can hardly believe that we have about one automobile for every six persons in the United States. Furthermore, the maintenance of this great fleet of motor vehicles will be possible only so long as the petroleum industry keeps its production on the present high level, keeps its great refineries running night and day, and keeps finding new markets for its many by-products, the greatest of which is fuel oil for heating. It must not be forgotten that nearly one-half of every barrel of crude oil is fuel oil and it is only by its disposal that the price of gasoline can be kept at a low level.

In exactly the same way, the oil industry is largely responsible for the great possibilities of the airplane. This industry is forging to the front and is creating industrial history quite as rapidly as the automobile, the radio, and oil burners. Without the internal combustion engine, the airplane would not be possible and without gasoline of the highest grade, the aviation engine would not be possible.

But the automobile and the airplane are not the only modes of transportation which owe a debt of gratitude to petroleum. Take, for example, the steam railroads. The first locomotives burned wood. If we never had had any other fuel but wood, how far would we have progressed with our great transcontinental systems? Then came the era of coal, and most of our steam railroad mileage is operated by coal today. Now we have the oil-burning locomotive which in some sections of the country has marked a great step forward in railroad transportation.

Thousands of locomotive firemen are rejoicing today because of the discovery of liquid fuel, for instead of their runs being continuous arduous tasks of shoveling coal, they are riding like princes on the seats of their cabs, gazing out of their windows at the track ahead, safeguarding their own lives as well as the lives of the traveling public. One hand rests on the lever of an oil-regulating quadrant by means of which they can instantly increase or decrease the flow of fuel passing into the fire box. When a locomotive is changed from coal to oil, its tonnage is increased 15 per cent, for the full boiler pressure of steam can be maintained at all times. Even while going up the steepest grades, the steam pressure in the boiler is not lowered and there is absolutely no smoke. As there are no smoke or sparks emitted, the danger of setting fire to forests, bridges, buildings, etc., is eliminated, and, because of this fact, oil-burning locomotives are used in coal mines, on divisions passing through timber lands, etc. Before oil was introduced, timber of in-

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estimable value was destroyed in many sections of the country.¹

But, says someone, sooner or later all the steam roads will be electrified and then what will become of the oil-burning locomotive? True, steam railroad executives are thinking in terms of electrification of main lines, but this will be a long and expensive process of installation. According to Mr. Britton I. Budd of the Public Service Corporation of Northern Illinois, the total railroad mileage now operated by electricity is about 1,800 miles of line and 4,000 miles of track. In his report as chairman of the Electrification of Steam Railroads Committee of the National Electric Light Association, he says that of all the roads concerned this is about 2.5 per cent of the miles of line and 3 per cent of the miles of track. For the entire country this is about 0.7 of the miles of track. There are 100 railroads in the world with electrified systems in operation or under construction, distributed through 35 countries on all continents.

"Conditions are quite different in the United States from most of the European countries," says Mr. Budd in the report of his committee. "Electrification has been adopted here for specific purposes in widely separated parts of the country. Each railroad has attempted to employ the system best adapted to its own particular problem. The results have been generally satisfactory with whatever system has been adopted, as is testified by the operators in each case."

The time may, and undoubtedly will, come when

¹*Burning Liquid Fuel*, by William N. Best.

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most of the big railroads will have dispensed with their motive machinery; their trains will be moved by central generating plants selling them power on meter just as power is being sold to operate the oil burner in the basement in the home or to operate the sewing machine, the vacuum cleaner and the electric ice box. But even when that time comes, there will still be many lines where the traffic density is so light that the expense of electrification will not be justified for many years to come.

And even though all of the railroads may become completely electrified, fuel oil will still be making a notable contribution to cheap transportation. This contribution will be due to the installation of oil burners in power plants generating electricity by steam. Today, in those sections of the country where oil is cheap, it is being used extensively in stationary boilers. It insures perfect combustion and a constant even fire, whereas in burning coal, it is impossible to keep up an even heat because the fuel supply has to be constantly replenished. Furthermore, there is no expense for the handling of fuel and ashes. One man can fire and water-tend a battery of twelve oil-fired boilers, thus eliminating an enormous amount of labor expense.¹

In power houses furnishing motive power for traction lines, there are about three or four hours in the morning and three or four hours late in the afternoon where the demand for power is twice as great as it is during the rest of the day. The engineers of a power plant using oil burners have no difficulty in developing double the normal rated

¹ *Burning Liquid Fuel*, by William N. Best.

horse power without the necessity of keeping extra boilers with banked fires. In some plants where coal is ordinarily used as fuel, the boilers carry the peak loads by using a combination of oil and coal.¹

Large electric light plants using coal must have a long battery of boilers with banked fires to meet such emergencies as storms or threatening weather when many lights are turned on simultaneously. By using oil burners, a boiler can be suddenly called into service at any moment and 150 pounds of steam pressure obtained within ten minutes. So that even though the steam railroads may be entirely electrified in the future, oil as fuel for the generation of power will be an important factor in transportation just as it is an important factor in street railway transportation today.

Just as fuel oil is coming into its own in land transportation, so is it occupying an important place in marine transportation. In a later chapter we will see how the American Navy is now composed of ships which are oil-burning. What applies to the navy also applies to the merchant marine. Modern shipping is being rapidly transformed from coal-burning to oil-burning. Oil is easier to handle, easier to load, requires less cargo space, and requires less crew in the engine room.

Leaving transportation, we find oil being used as fuel in many other industries. It is an ideal fuel for steel foundries because a maximum output is obtained from the furnaces. Where producer gas is used but two heats a day can be obtained, while with oil three heats can be obtained. In the heat-

¹ *Burning Liquid Fuel*, by William N. Best.

treating of steel, it is important that the temperature in any portion of the charging space does not vary more than 10 degrees. This condition is easily maintained with oil burning. Furthermore, oil, having a much higher calorific value than coal, is used successfully in malleable iron, grey iron, and brass foundries where it will melt the metal in a much shorter period of time and will bring it to the temperature required for even the smallest castings.

"The blacksmith requires more judgment than any other tradesman," says Dr. William N. Best. "He has always been known to history. In the Bible, we are told of Tubal-Cain, that ancient forger of cutting instruments of brass and iron. He evidently was not only a man of brawn but also of brains, for he was the maker of articles having great tensile strength. He was a scientist who knew the value of heat and he made his contribution to the world. His name has been immortalized because of his knowledge of heat and metals."

The blacksmith—or perhaps I had better call him the forgerman—is an indispensable tradesman and may even be said to be a world power. He must know mechanics, metallurgy, drop and steam hammering, forging machines, temperatures, furnace construction, and above all, fuels. Today oil is accepted as the incomparable fuel for forging and the heat-treating of metals. A plant using oil in its forging and heat-treating furnaces can turn out 100 per cent more work of a better quality than that of a plant using coal as a fuel. To change from coal to oil in a manufacturing plant is like changing

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from a tallow candle to an incandescent light.¹ And so again we find fuel oil contributing to our industrial supremacy.

Oil is used as fuel in innumerable other industries. It is used in sugar refineries, boiler manufactories, in the copper industry, in the chemical industry, in the manufacture of pottery, in the rotary kilns of cement plants, in dryers and ore roasters, in bread and cracker oven equipment, in candy-making, in connection with oil and gas still equipment, in the glass industry; in fact, in practically every industrial enterprise where there is need for heat—and every industry needs heat in some form at some point in its processes.

¹*Burning Liquid Fuel*, by William N. Best.

CHAPTER XV

Fuel Oil and Electricity

EVEN the most casual survey of American industry today will demonstrate in startling fashion the "interdependency" and "interrelations" of the various members of our great industrial family. A hundred years ago, industry might be described as largely individualistic. The phrase "mass production" had not been coined. Markets were largely local due to lack of adequate transportation, and the needs of the manufacturer were confined to a supply of raw material and labor. He did not depend upon—and gave little thought to—any industry other than the one which supplied him with his raw materials. There was no such thing as "interdependency" of basic industries. This, of course, was before the intensive development of fuel utilization.

Today the situation is quite different. The manufacturer depends not only on an adequate supply of skilled labor for his fabricating processes but he is also dependent on an adequate and continuous supply of cheap power. The worker of today no longer performs his tasks by sheer physical labor. He has become a director of power. The average American worker has at his command at least $4\frac{1}{2}$ horse power of mechanical power and as a consequence can do the work of a dozen or even a score of his forefathers. The result has been what we

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now call mass production; a force in American industry which has brought about that paradox—a reduction of the unit cost of manufacturing accompanied with a steady increase in the wages of the workers.

With the coming of mass production, the manufacturer has found that he is dependent on many other industries besides the one which produces his raw materials. He is dependent on adequate and speedy transportation both for his raw materials and for the extension of his markets; he is dependent on a continuous and ample supply of cheap power; he is dependent on the manufacturer of machinery and equipment for the devices by means of which his worker translates that power into mechanical workers at the beck and call of the human worker; he is dependent on the prosperity of all other industry for, with his constantly increasing production, there must be a constant increase in the buying power of the mass of the people; a lack of prosperity in any considerable portion of industry means unemployment and a quick falling off in buying power; in fact, the interests of raw materials, transportation, manufacturing, and distribution are so interwoven that our whole industrial structure—which includes everything from agriculture and mining to factories and railroads—is but little more than a great chain which is no stronger than its weakest link.

In this great system certain industries have a community of interest which stands out over and above the general community of interest shared by all industry. Such industries are oil and power. At

the present time, it seems that a considerable portion of the future prosperity of these is dependent on one another. By this I do not necessarily mean that the future production of oil depends on the future production of power *per se*, or that the future production of power depends on the production of oil *per se*, although each is necessary to the other to a very large extent. I mean that the extension of the markets of each and the necessary reduction of cost to the ultimate consumer which is a natural result of the extension of markets are dependent, one upon the other.

A good example of this is the case of the California Edison Company. With the coming of hydro-electric power, it was thought for a time that the cost of the production of power had reached its lowest level. But the light and power industry knew differently. It knew that even if the entire potential water power resources of the United States should be fully developed by 1935, this water power would only supply about 35 per cent of the country's power demands. This brought about a realization of the necessity of improvement in methods of generating electricity by means other than water power.

One of the first results has been a tremendous improvement in the generation of steam with coal for fuel. In 1919, the average use of fuel in all the power and light plants in the United States was 3.2 pounds of coal per kilowatt hour. Last year, this had dropped to 1.8 pounds, with the newest individual plants operating upon as little as 0.9 pounds. It may well be that the time will come

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when it will be much cheaper to generate power with coal which costs something than with water which costs nothing. This, of course, is due to the much greater capital requirements in many hydro-electric enterprises.

With the development and improvement in methods of burning fuel oil, a new factor entered the field. Where fuel oil is cheap, it is much more economical to generate electricity in oil-burning steam plants than it is to generate it by water power or with coal-burning plants. This has been the experience of the California Edison. Fuel oil of good quality is abundant and cheap in California. This company has found that it can generate electricity with its oil-burning steam plants more cheaply than it can with hydro-electric plants, even though the water power is located in the immediate locality, and of course it can generate with fuel oil much more cheaply than it can with coal. Consequently, it has adopted a policy of developing no more water power for the present. This is a fact which is persistently overlooked by those who advocate the development of a great water power project at Boulder Canyon, 250 miles from Los Angeles. They seem to think that by some peculiar magical means, the government can manufacture power at Boulder Canyon and transmit it over 250 miles at less cost than it is now being manufactured in Los Angeles itself. Yet, the California Edison emphatically states it can manufacture with fuel oil more cheaply than it can with water power located within its own area.

In this particular instance the improvement in

methods of fuel oil burning has reduced the cost of production of power. Cheaper power means an extension of markets for fuel oil. An extension of markets for fuel oil means cheaper oil and cheaper oil means a still further reduction of the cost of production of power. Thus the two industries working together and side by side are gradually reducing the cost of production of both to the benefit of the ultimate consumer. It should also be noted that the use of manufactured gas for the production of power is increasing and that in many instances petroleum is one of the raw products in gas making.

This sounds more or less abstract and academic and is not particularly easy to visualize. It is a formula, however, which does seem to be working out. Its immediate effect on the individual is not always apparent, for to appreciate it we would have to trace the effect of a reduction in the cost of power on the cost of all other commodities. Suppose we take for an example something with which the consumer has the opportunity of coming in daily contact in his own home.

The oil burner in the furnace in the cellar increases the so-called domestic load of the light and power company in that particular home materially. Every time a householder installs oil heating, he becomes a customer for a small amount of additional electric current. Therefore, the more oil burners which are sold in the United States, the greater will be the market not only for oil fuel but for domestic electricity. The greater the so-called domestic load for electricity, the lower will be the unit cost of electricity for this type of service. In other words,

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the householder by installing an oil burner in his furnace is making an individual contribution to some future reduction in the cost of all of his domestic electricity as well as that of his neighbor.

This question of reducing the cost of domestic electricity is one of considerable importance to the householder desirous of installing as many labor-saving devices in his home as possible. According to Mr. H. T. Sands, former president of the National Electric Light Association, the household consumption curve is steadily rising. "It is estimated that the average home in the United States consumed 5 per cent more electricity in 1927 than in 1926 and for this same period the average household bill for electric light and power increased only about 2 per cent. During 1927 the average cost per kilowatt hour for domestic consumers decreased from 7 cents to $6\frac{3}{4}$ cents. This is incontrovertible evidence of the caliber of the service that the electric companies are giving to the country. These trends toward improved service and lower rates are continuing and it is apparent that the domestic load will become heavier as widespread appreciation of home electrification is fostered by electric light and power companies, manufacturers, contractors, jobbers and dealers."

There are in the United States over 18,000,000 homes wired for electricity. A considerable proportion of these are in rural districts where coal is not available for fuel for heating and where there is no gas. There is no hamlet so small, however, which cannot be reached, and which is not reached, by a tank wagon of one or more of the oil com-

panies. For this we have the automobile to thank. If the oil companies can distribute gasoline profitably to these remote areas, they can distribute fuel oil. It is therefore logical to say that every one of these 18,000,000 homes is a potential customer for oil fuel for it is already possessed of the other necessary service—electricity.

Here again we see the interests of the two industries traveling side by side. An increase in the demand for one means an increase in the demand for the other. Every time an automatic oil heating plant is installed, the local light and power company is going to sell a little more electricity and the local fuel oil distributor is going to sell a little more fuel oil. The markets of both commodities are being gradually extended and the cost of both kept down.

The first objection to be raised to ideas such as these is that the oil-burner load for light and power companies is a seasonal load; that at best it is only for six or seven months of the year. This being true, it would seem that any large addition to the domestic load for heating purposes would mean a considerable amount of idle equipment in the warmer months. In other words, the local light and power company, serving a community in which there are installed a large number of oil burners, must be equipped to furnish the necessary amount of domestic current during the winter months and some of this equipment would be idle during the summer months.

To this, the first obvious answer is that electric refrigeration will take up the slack in the summer. In the winter, the electric ice box presumably re-

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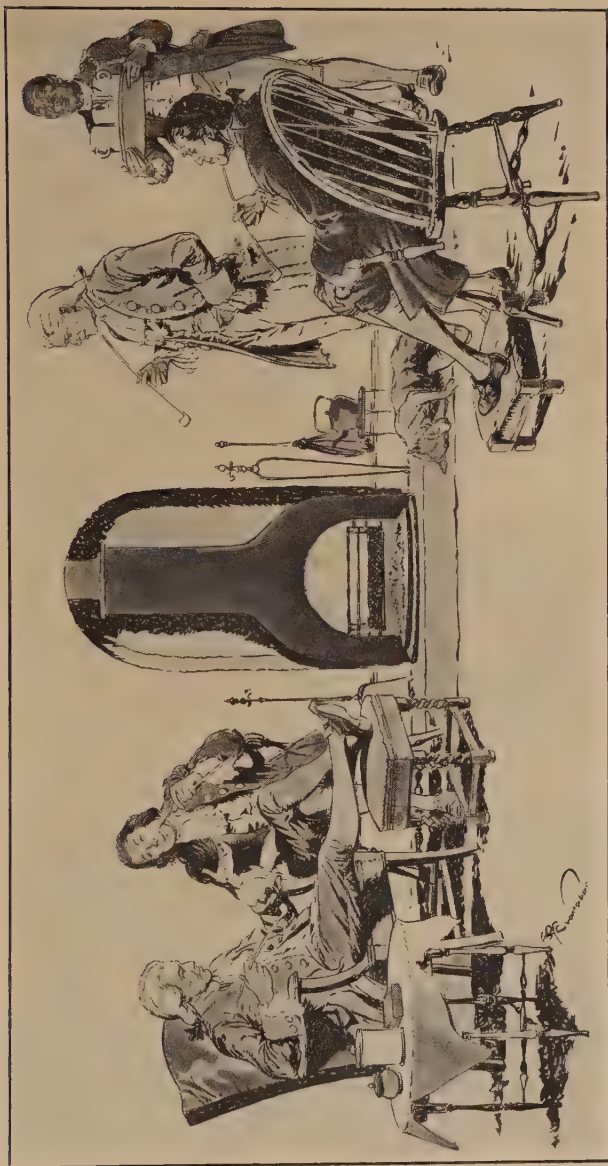
quires very little current while the oil burner requires a great deal, comparatively speaking. In the summer, the ice box requires a great deal of current and the oil burner none. It would therefore seem that the electric ice box and the oil burner doing team work would make this particular type of domestic load an all-year-round load instead of a seasonal one.

To this, the light and power official replies that up to the present time, electric refrigeration has been installed only in the homes of the more or less well-to-do and that the ice box itself is in a heated home and requires quite as much current in the colder months as in the summer months. No doubt it is true that, until recently, the high first cost of an electric refrigerator has confined its installation to homes where it made little difference to the householder whether it was installed in a warm pantry where it used \$3.00 worth of current a month or in some outside pantry or even on an enclosed porch where it used only \$1.00 worth of current a month. This condition, however, will not last long. With the increasing popularity of electric refrigeration and an appreciation of its great convenience and eventual economy, there will be a gradual reduction in the first cost. More and more homes owned by those in moderate circumstances will be equipped with it. This means that there will be more and more people having this great convenience who will install it where they will get a maximum amount of service at a minimum cost. There will be an appreciation of the fact that there is no more reason for installing an electric ice box in a warm kitchen

or pantry than there was for installing an old-fashioned ice box in a similar place. It will be placed in an outside pantry or even in the cellar just as so many ice boxes are placed in the cellar to conserve ice. The winter refrigeration load will drop and be replaced by the oil-heating load. In summer, the oil-heating load will drop and the electric refrigeration load will advance, thus effecting an equalization of load which will make its domestic business an all-year-round affair.

This scheme for meeting the problem of seasonal loads is, so to speak, already in the works. Electric refrigeration is a fact and is becoming more and more popular every day. It has not only demonstrated its practicability but, what is much more important, its economy and its convenience. In its way, it means quite as much to the housewife as the vacuum cleaner, the electric iron, or the electric sewing machine. It is making its contribution to the elimination of drudgery in the home. In the same way, automatic oil heating is an accomplished fact. It, too, has demonstrated its practicability and has also demonstrated that it is more economical than a coal-burning plant, although this claim is still disputed. Certainly it has done more than any other single device to eliminate drudgery in the home. The time is rapidly approaching when these two most important contributions to the comfort and convenience of housekeeping will to a certain extent equalize the domestic electric power load as between winter and summer.

There is another scheme pending, however, and one on which the electric industry is hard at work.



FRANKLIN STATED THAT HIS STOVE WARMED HIS ROOM TWICE AS WELL WITH ONE-FOURTH
THE WOOD REQUIRED BY A FIREPLACE

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There is no real reason why the same unit of equipment in the cellar should not only heat the house in winter but cool it in summer. In fact, I firmly believe that the time is coming when the same unit of equipment will heat the house in winter, cool it in summer, serve as a refrigerator for food supplies, heat the water and dispose of the garbage. Engineers who have earned the right to speak with authority tell me that this is so.

In *Aladdin, U. S. A.*, I described at some length the fundamental research work which is being done by the electric industry. In the chapter on this subject I said:

“Every industry must be constantly seeking ways and means of widening its field of possible customers, or of developing processes by which present customers become larger consumers, or both. To do this, it must constantly improve the quality of its products and must constantly strive to reduce unit costs. Both depend on the industrial research laboratory. The reduction of costs is brought about by refinements in process and by mass production. There is nothing particularly altruistic in these efforts. Lower costs and greater volume mean increased profits per dollar invested. This has been proved in every line of business endeavor from manufacturing to retailing.”

Perhaps the best example of this—and one which demonstrates the thesis I am attempting to present—is the development of the Mazda lamp by the General Electric Company, named after that

same Ahura Mazda, the god of light of Zoroastrianism described in the first chapter. This lamp gives exactly four times as much light with the same amount of electric current as the carbon filament lamp of 1900. Has this cut down the income of the electric industry from domestic lighting? Not at all. It has simply released a large amount of current for other purposes, such as more and cheaper power. It has, in fact, greatly increased the volume of business done by the companies, while at the same time it has given the consumer an infinitely better product at a greatly reduced cost.

In exactly the same way, anything which will enable the light and power companies to take on an increased load of domestic power will reduce the cost to the consumer and make for cheaper power. The industry realizes this and knows it must meet and solve the problem of seasonal load due to oil burners. This it is in the process of doing and one of the solutions suggested is to have the same unit which heats the house in winter cool it in summer. The scientists tell us that this is not only feasible but that it is almost an assured fact. Thus will fire, and fuel with which to feed it, because of their demands on another industry, be largely responsible for still another device which will add immeasurably to the comfort of man.

CHAPTER XVI

Oil and National Defense

ACCORDING to Dr. Edwin S. Slosson, writing in *Collier's*, "The Germans realize that they were beaten in the late war by American petroleum." According to Admiral Sims, "The naval strategy of another war will be greatly concerned with assuring ample and continuous supplies of petroleum and its products because it is essential as fuel not only for surface craft, but even more so for submarines and aircraft." This is of great interest when we consider that, with the conversion of the battleships *New York*, *Wyoming* and *Utah* from coal burners to oil burners, the entire line of battle of the American navy will be composed of oil burners. Commenting on this fact, Admiral Sims has also said:

"Great Britain has established great stores of oil all over the world; Japan likewise has accumulated vast reserves of this munition. All navies are now on the oil-burning basis because oil requires less space, can be more conveniently stored aboard ship, produces 50 to 60 per cent more power per ton, and requires a considerably smaller crew. No other naval power possesses its own oil as does the United States; yet so important is oil that there were times during the war when English

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commanders were under orders not to proceed at more than one-half or three-quarters speed, except when confronting the enemy, in order to conserve oil."

Because it has made possible the airplane and the submarine, oil has brought about a revolution in warfare. For example, the naval blockade, by means of which a superior power closed the ports of an inferior power and cut it off from communications, is no longer possible. All a minor power needs is a fleet of aircraft and a fleet of submarines to make the maintenance of such a blockade impossible. In other words, according to Admiral Sims, "the battleship is no longer an asset." Even on the western front during the war, guns placed on solid earth are supposed to have required 65,000 shots to one hit against aircraft. What chance have anti-aircraft guns on the deck of a rolling ship? As to submarines, they are now building them of 3,000 tons, carrying enough oil to circle the world without refueling.

The airplane and the submarine are sure and comparatively inexpensive instruments of defense. This is why, when Great Britain at the Washington Conference on Naval Armaments in 1921, sought to outlaw the submarine, the other nations would not agree. This would have assured her superiority in fighting craft and naval bases.

The conversion of the last three battleships to oil burners marks the end of an era in the navy's history. That era began when Robert Fulton built for the government the first steam-driven warship.

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She was called the *Fulton* and although of only 38 tons was described as a "fire-eating monster." For a century thereafter, coal produced the navy's steam power; then in 1914 came the battleship *Nevada*, one of the first of the oil burners. Since then oil has been the standard fuel of all navies. In an interview in which he commented generally on the lessons of the war, Admiral Sims said:

"The fact that the Allies had the great oil resources of the United States to draw on is now recognized as one of the important factors in giving them victory. But in general, the war's demonstration of the industrial and financial capacity of the United States forced a revision of all calculations regarding the seats of power in this world. Our immediate adoption of universal service, the prompt registration of 10,000,000 men under the Universal Service Act, the proof of our unparalleled ability to produce the necessities of life and of war, the transport of 3,000,000 troops to France in circumstances which the enemy had believed made such a movement impossible, the demonstration of our enormous financial capacity—all these things compelled a sweeping recasting of all calculations about locations and alignments of power. Our great population, resources, wealth and industrial capacity constitute the surest guaranty of peace for a long future, provided we pursue wise policies. Having no reason for aggression,

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our naval establishment should be adapted to assure the best defense.

"For instance, as to our requirements of aircraft. Suppose we confront an alliance of two powers against which we must defend ourselves. The first thing to be considered is not their combined number of battleships and cruisers, but their force of airplane carriers. Assume that the two powers together have six carriers with a capacity of 50 planes each. Then we must be prepared to deal with 300 airplanes along our coast, for the modern airplane carrier is considerably faster than a battleship and has a cruising radius of 6,000 or 7,000 miles. So we will need a force of airplanes sufficient to smother the enemy's 300. The enemy might possess thousands of airplanes, but we would be confronted only with such number as he could bring, with his equipment of carriers, to our coast.

"A combination of powers might present a large superiority in battleships and cruisers. But to attack us, they would have to steam to our shores, and these vessels can carry only about enough oil for the round trip from Europe. In order to remain here and conduct a campaign, they would have to bring colliers with fuel and have an advance base near our coast, and so our problem of defense against them would be principally, with our submarines and aircraft, to pick off and sink the colliers and other auxiliaries. On the basis of experience and demonstrations, that

would be no difficult task, for the big planes can carry a bomb of from 2,000 to 4,000 pounds. Dropped on the deck of any fighting ship or in the water within a short distance on either side, one bomb would finish her, and the proportion of hits in such operations is so high that the fleet would have no chance. It is not commonly understood how big a target a battleship presents to a bomber. If the ship be 600 feet long and 100 feet beam, then a great bomb that strikes her, or within 50 feet on either side, will be fatal; its target represents an area 600 by 200 feet. The bomb which falls in the water near the vessel sinks to a certain depth and explodes, like a depth charge, against the unprotected part of the ship, below the water line. It is even more deadly than if it had fallen on deck.

"The navy of the future should be particularly strong in aircraft carriers. We have one, the *Langley*, completed; an experimental craft of only 15 knots. The *Saratoga* and *Lexington*, which are nearing completion, will carry 75 planes each and make about 30 knots an hour against perhaps 23 for a battleship. With such a speed a carrier's program is to keep out of range of the battleships and cruisers and send her aircraft out to bomb them.

"Instead of building more cruisers of 10,000 tons, which are permitted under the Washington Conference agreement, sound naval practice would be to construct aircraft carriers. The battleships and cruisers, with their steam-

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ing radius of about 6,000 miles, are not to be compared to submarines with four times that radius. It must be remembered that normally the submarine steams on the surface, going below only when there are reasons for concealment.

“The big new submarines can do around 100 miles under water at 7 or 8 knots. On the surface they use oil for power; under the surface, electricity from storage batteries. A submarine can lay mines anywhere, even across the widest ocean. If it be suggested that the chance of sinking shipping with mines is rather remote, my reply is that at the height of the submarine campaign, the British Admiralty was using 600 vessels constantly as mine sweepers to keep clear the approaches to harbors of the British Isles. That many vessels were lost to other services for which they would have been enormously useful.”

But the story of oil as fuel for airplanes, battleships and submarines does not complete the history of the contribution made by the oil industry during the war. For example, in 1918 there was a great lack of crude oil on the Atlantic seaboard and pipe lines had to be pushed to the limit of their capacity. A number of pipe line companies agreed to build loops on their various lines and add to their pumping equipment, while others built hundreds of miles of new lines, all at their own expense and involving millions of dollars.

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Any examination of the great mass of the official reports that go to make up a large part of the unwritten history of the Great War, emphasizes the place of oil not only as a romantic, but as a determining, factor in the results as they were.

CHAPTER XVII

Some Thoughts About Conservation

IT IS a characteristic of the American people that they must have something to worry about. This is healthy enough if the worrying is constructive. To worry just because of a congenital fondness for worry, *per se*, is bad for the liver, digestion and one's outlook on life. To worry about facts rather than make an effort to adjust one's mental attitude so as to live in some kind of peace and harmony with them is only a waste of time and effort. To worry about some given set of conditions in such a way that the expression of it brings about a change for the better is constructive and good for man and beast.

The American people are given to worrying about all sorts of things. They worry politically about the party in power; is it giving the country a wise, economical and businesslike administration or is it operating the government for the benefit of some favored members of the party? They worry about the party out of power for fear that if it comes into power it will give the country a worse administration than the party in power. They worry about good men in office for fear they will not stay in office and they worry about blatherskites in office because it seems to be so difficult to replace them with men who are not blatherskites.

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They worry about organized labor, socialism, communism, welfare work, transit problems, the height of buildings, pacifism, the yellow peril, the League of Nations, the sportsmanship of prize fighters, fundamentalism, evolution, the Anti-Saloon League, the Americanism of this candidate and the religion of that, state rights, federal interference with business, lobbying, trusts, the cost of living, unemployment, Henry Ford, and a host of other matters which if listed would fill a good-sized volume of reports for the Bureau of the Census. Any metropolitan newspaper or any serious or frivolous periodical is filled with plain and fancy worries to plague the reader from the time he gets up in the morning until he goes to bed, and to trouble him in his dreams after he has gone to sleep.

One of the great outstanding worries which we have always with us is the worry about natural resources. For instance, a considerable number of persons are sure that in a little while these United States will have no water-power resources because we are giving them all away to the so-called "power trust." They seem to be of the opinion that once an individual or group of individuals is authorized to develop some potential water power, forever after it will be used only for the benefit of these individuals, while no one else can get a single kilowatt from them. They do not, or will not, understand that 85 per cent of our water power comes under the Federal Water Power Act; that the public always has the right of recapture; that people develop water power in order to furnish electric service to the public; and that the price of that electric service

is controlled by law. Nor do they seem to realize that by utilizing the flow of a stream to operate a turbine which in turn operates a dynamo, the water is not used up; it is still water and it is still there.

We worry about all sorts of other natural resources; about coal and lumber and iron—at the present time, we are worrying a lot about oil. “After oil—what?” is one of the outstanding questions of the day. We are told that the present available supply of oil in the ground is about $26\frac{1}{2}$ billion barrels and that we are using this up at the rate of 900 million barrels a year, with the logical inference that in about thirty years there will be no longer an American petroleum industry.

One is reminded of the early days of oil when it was feared that the Pennsylvania fields would soon be exhausted. At that time someone suggested that oil might be found in Oklahoma and Texas. This was repeated to Mr. John Archbold, that early pioneer who afterward became a tremendously efficient executive of the Standard Oil Company. “H—ll!” said Mr. Archbold, “I’ll drink all the oil they ever find in Oklahoma or Texas.”

Stephen Leacock, the economist and humorist, gives us an amusing picture of the pessimists crying aloud in the wilderness over the immediate exhaustion of all our natural resources. He warns us that everything will have run out in fifty years’ time and that we had better make the most of things while they last. In another generation, he says, the whole continent will have turned into farms, fields, motor roads, and the motor cars will have penetrated everywhere.

SOME THOUGHTS

"Motor cars, did I say? I fear I am in error there again. In forty years there will be no motor cars. Petrol, it is certain, is running out. Professor Glumb, of Midnight, Alaska, has just made a calculation to show that at the rate at which we are using up the world's petrol the supply will end in forty years.

"He warns us that even now he can see only 4,000,000,000,000,000 gallons in sight. There may be just a little more, he thinks, under the Red Sea; he has not been down, but he doubts if there's more than a couple of million billion barrels. The motor cars will stand parked in rows, and it won't be possible to move them an inch.

"And what is worse, it won't be any use trying to substitute coal. There won't be any. It is to run out the year before petrol. Our reckless use of it through the nineteenth century has brought us to the point where there are only 10,000,000,000,000 (ten thousand billion) tons left. Assuming that we go on consuming it even at our present rate, the last clinkers will be raked out of the last furnace in 1964."

The facts are that almost as soon as some astute individual or group of individuals known as a committee of something or other completes a survey of the available oil supply and makes a report, new and heretofore unheard-of fields are discovered. For example, "there appears to be no end to new discoveries and production in the West Texas field,"

writes Mr. Isaac Marcossou in the *Saturday Evening Post*. "In the now famous Yates pool, two 20,000-barrel wells and one 85,000-barrel well were discovered late in November [1927]. It is estimated that the potential daily output of Yates is more than 300,000 barrels." This discovery came long after the estimate of 26 billion barrels as the total oil supply. There are innumerable other examples of a similar nature.

But additions to our oil reserves are by no means confined to new fields and new supplies. New methods and more efficient operation are constantly rejuvenating old fields, as for example in Pennsylvania, where the output today is actually greater than it was ten years ago. The "reclamation process," as it has been called, consists of four operations: deeper drilling, water flooding, air and gas lifting pressure, and mining.

Deeper drilling is just what the name implies and has made the greatest contribution to new and additional production in old oil fields. Colonel Drake's well, the first drilled oil well in America, was only 69 feet deep. In California, they now drill wells as deep as 8,000 feet. An interesting example of what can be done with deep drilling is found in the Ventura field, 60 miles northwest of Los Angeles. In 1915 prospectors drilled to a depth of 2,250 feet, but the well was not a paying producer and work was stopped. In 1926, eleven years later, a commercial well was brought in at 6,000 feet and this field is now producing 60,000 barrels a day. At Spindle Top, where oil history has been made, the original wells never went deeper

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than 1,000 feet and when these were exhausted, the field was abandoned. In 1926 oil was discovered at 5,000 feet and it is now estimated that this area will yield 60,000,000 barrels. It may very well be that with deeper drilling and improved methods of production, the old fields will be quite as productive as the newly-discovered ones.

But the oil supplies of America are by no means confined to the old fields, or the newly-discovered fields, or the old fields rejuvenated. When they are completely exhausted at some distant future day, we will then have the so-called "synthetic reserves." "Oil shales" from which oil can be distilled are supposed to have a total oil content greater than the entire supply from wells. Next are the lignite and low-grade coals. Two of the largest oil companies in the world have, according to reports, thought enough of a method of distilling oil from this source to acquire patents covering such distillation. As a matter of fact, there is every evidence that our oil supply is assured for literally hundreds of years, in spite of the fact that periodical scare headlines warning of its untimely exhaustion have led the public to believe firmly that it must be true. This does not mean that wastefulness either in methods of production, refining or utilization is in any way excusable; it does mean, however, that we need have little or no hesitancy in developing new uses for petroleum and its products and stop worrying about the pessimistic forebodings of statisticians.

The trouble with most professional conservationists is that they don't appreciate the true meaning of the word "conservation." Running all through the

literature on conservation of natural resources is a thin but definite line of false economy. It is the same curious philosophy which causes the miser to shorten his life by malnutrition, or the hoarding of anything just because of love of possession, or as against some future but indeterminate day of unexpected need.

All of which brings up the question of what is conservation—true economy in dealing with natural resources? Is it hoarding them, keeping them locked up for some future generations, centuries remote from the present? Not at all. There is no conservation in failing to develop a potential water power if there is need for that power. Water over the dam is water over the dam and will never return to turn a water wheel for our great-great-grandchildren. Standing forests, protected from the lumberman's axe by a paternalistic government, subtract rather than add to the national wealth if there is need for the timber for housing or the thousand and one other uses for this country, which, after all, is largely built of wood. The capped oil well is an economic loss, if it means a shortage of gasoline with the consequent rise in the price of gasoline for the millions of people who find today that the automobile is not a luxury but a necessity. Coal locked up in the ground is but poor consolation for the housewife who must serve a breakfast of cold cereal because the gas company has been unable to get a sufficient supply of coal with which to manufacture gas.

True conservation is nothing more or less than the elimination of waste (this does not mean only

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the elimination of waste materials—it means the elimination of wasteful methods) and the better utilization of raw materials. That is all. A simple enough policy if carried out in a practical manner. Applied to the production of oil, for example, it means that if there is a real need for, say, 5 billion gallons of gasoline the industry should produce 5 billion gallons of gasoline, provided always that the industry can find ways and means of utilizing all of the other products of that petroleum production.

The Russians called oil fuel refuse oil. The great problem of the petroleum industry is not the regulation and curtailment of production; that can, with little effort, be retarded to an amount equal to the demand. Rather is it a problem of utilization of the enormous quantities of oil fuel resulting from the production of sufficient gasoline to supply the demand.

The solution of this problem is the solution of the future price of gasoline. The sale of the by-products of the packing industry keeps down the price of meat. The development of a daytime load keeps down the price of electric lighting in the home. The development of a market for oil fuel will keep down the price of gasoline and lubricating oil and this is true national economy—conservation at its best.

The more extensive and better utilization of oil fuel, a by-product in refining petroleum, is progressing more rapidly today than almost any other similar movement. It may be divided into two distinct classes. The first is the use of oil fuel in place of coal in industry, in the production of electric light and power and in transportation. Here the use of

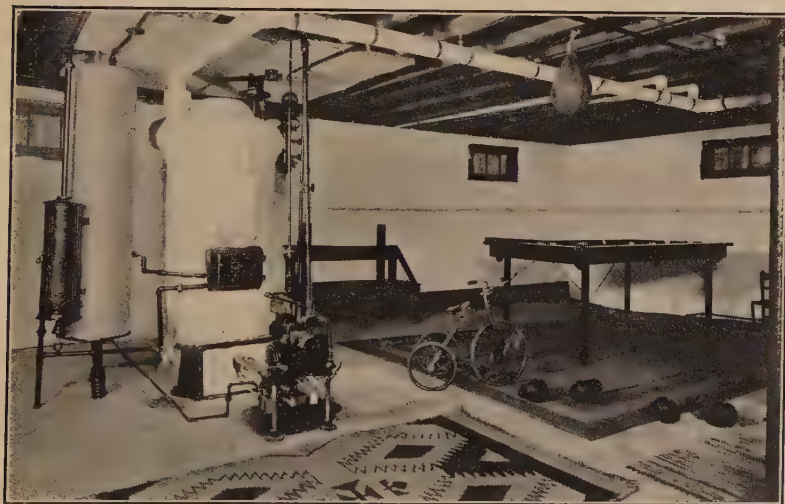
oil fuel is entirely governed by the relation of its cost to the cost of some other kind of fuel. In California, as we have noted before, the California Edison Company has announced that for the present, at least, it will develop no more water power as it can generate power with steam plants, using oil fuel, at a smaller cost than developing by hydro-electric power. If water which runs downhill and costs nothing cannot compete with oil fuel in this territory, coal never will be able to do so. When, however, industry or other great enterprises find that oil fuel costs more than coal, they will return to coal or perhaps to some synthetic fuel which sooner or later will be devised by science.

The second use for oil fuel is in the home in place of coal. Here the question of economics does not play quite so important a part. Even if the cost of oil fuel should become considerably more than the cost of coal to give a certain amount of heat in a private home, there are so many distinct advantages in the use of the oil-burning furnace that very few people, having once used oil, will be willing to return to the old-fashioned coal-burning furnace unless the price of oil fuel should become prohibitive, which seems at this time to be hardly possible.

It is because of these facts that the progress of the oil burner industry has been so rapid the past few years. The oil industry itself, realizing that the demand for gasoline will be constantly on the increase, requiring more and more petroleum and therefore resulting in more and more oil fuel as a by-product, has turned to the millions of homes in the United States as a possible market for it. As



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we have seen in a previous chapter, there are 18,000,000 homes in the United States wired for electricity, and of these 18,000,000, nearly one million are being heated with oil-burning furnaces. The other 17,000,000 are a potential market today, to say nothing of apartment houses and hotels. This domestic market is steady and dependable. Regardless of the condition of industry and regardless of the cost of living, homes must be warmed in cold weather. With an assured market for oil fuel, the price of gasoline is automatically stabilized and there need be no fear that the day will come when, like the people of Europe, we will be paying fifty, or sixty or even seventy-five cents for gasoline.

In advancing the interests of oil burners in the home, the oil industry is practicing the highest type of conservation—better utilization of its products. Incidentally, it is helping to add to the comfort and convenience of the home dweller, a social matter of even greater importance. In the next chapter legislation for the conservation of petroleum supplies recommended by the Committee of Nine of the Federal Oil Conservation Board is fully discussed.

CHAPTER XVIII

Fuel and Politics

FOR some extraordinary reason, there always seems to be a definite group in all legislative bodies ever intent upon investigating success. Let an individual, or a group of individuals, or a corporation, or any form of enterprise meet with marked success because of the initiative and brains which normally go with success, and it is immediately suggested that there must be something wrong. According to their notion, prosperity is synonymous with dishonesty.

One sometimes wonders why our legislative bodies do not develop a new investigating policy, to wit: the investigation of failures. Certainly this would be more constructive than the continued effort to undermine public confidence by investigating success as though there were something sinister about it. Every year in the United States there are tens of thousands of failures involving millions of dollars of the money of thrifty citizens. Surely, if we must be protected from something, why not make an effort to protect us from the consequences of failure? No one has ever been permanently injured mentally, morally, physically or financially by success, but almost anyone can be permanently injured, at least financially and sometimes morally, by failure.

Certainly anyone would approve the investigation of a public utility which, because of crooked manipu-

lation and promotion, had resulted in the loss of the savings of a large number of people. But it is exceedingly difficult for the average citizen to condemn the public utility which has been a success, has made money for its security holders, has furnished profitable employment for a large number of people, and withal has given its community satisfactory service at reasonable rates. And I don't believe all the Senate investigating committees in the world can change this psychology, peculiar as it may seem.

Of the various forms of fuel—and I must remember that this book is supposed to deal with fuels—oil has received the most attention from the politicians. Gas, except where it has been tied in with the generation of electrical energy, seems to have escaped fairly well. Perhaps this is because during the last two decades there has been a feeling that the gas companies were having a hard struggle because of the competition of electricity. As a matter of fact, electricity has affected the prosperity of gas companies not at all; their prosperity has increased with the extension of the use of electricity. In any event and in spite of the fact that the gas business is a regulated monopoly, it does not seem to have proved an inviting field for the professional politician seeking issues. It has rocked along in its peaceful way, extending its service and improving its quality with little or no interference by politics.

The coal industry has had much the same experience. Every once in a while there is a more or less abortive effort to settle a strike. Occasionally there is a demand that the coal industry be investigated and reorganized. If all the coal mining op-

erations could be gathered together into the hands of a few large corporations, it *could* be reorganized, put on an all-year-round basis, and do many things which would be to the everlasting benefit of the ultimate consumer. But this, of course, might very easily be a violation of the Sherman Anti-Trust Law. The coal operators cannot even get together and organize production so that the industry can be put on some sort of an economic basis. In this way, coal and the users of coal have suffered at the hands of politics. It may be that some day those who guide our political destinies will see the light and learn finally the lesson of the railroads. If that time ever comes, the mine operators, the miners and the consuming public may render up devout thanks.

At the present time the skies seem to be clearing somewhat for the petroleum industry and it seems to have some chance of getting out of the political woods. The Federal Trade Commission, after making innumerable investigations ordered by Congress, seems to have definitely made up its mind that the oil industry is highly competitive. After the last investigation it admitted that "no recent evidence of agreements or manipulations of any size among large oil companies to raise or depress prices of crude petroleum or refined products was found" and that "price movements over the longer periods were controlled by conditions of supply and demand." It apparently has decided to take to heart its own pet injunction to "cease and desist," and for the time being will allow the Federal Oil Conservation Board to assume jurisdiction over one of the most important phases of oil production.

This is the phase which has to do with the serious question of overproduction. If we are to have true conservation (by conservation I mean elimination of waste and not hoarding) and if we really are concerned about the possible dissipation of our petroleum resources, then there is only one thing to be done: open the door to overproduction prevention. The only way to prevent overproduction is to limit production; and the only way to limit production is to find a way by which the crude oil producers can enter into some sort of cooperative agreement for that purpose unless we want to take an eleven-billion dollar dose of that allopathic patent medicine labeled "Government Ownership and Operation." This would no doubt be pleasing to that little group of serious thinkers who do not agree with President Coolidge and his decided idea that these United States are not founded on any communistic theory. But it would be distressing to 23 million automobile owners, to the hundreds of thousands householders who have installed oil heating in their cellars, to every industry dependent in any way on lubricating oils and to thousands of enterprises producing all sorts of necessities and luxuries obtained from petroleum, to say nothing of the hundreds of thousands of security holders and owners of royalty oil lands.

We hear a great deal these days about oil conservation and about the danger of exhausting our petroleum supplies in the near future. This was fully discussed in a previous chapter. There is much talk of prodigal waste. But while there is no waste *per se* in oil production (every gallon of

oil that is taken out of the ground is refined and the products of the refinery used), the facts are that there is great danger of overproduction. This overproduction is economically unsound. While the oil may be actually used in one way or another, the use of a greater amount of oil than is necessary to meet our actual requirements means a national loss and, incidentally, prices which make the production and refining of petroleum unprofitable. Yet the politicians, ever ready to criticise the industry for overproduction, are quite as ready to jump down its throat at any suggestion that the producers get together to limit production.

Why is it that the production of oil is not governed by the laws of supply and demand just as the annual production of automobiles, or shoes, or steel falls within those laws? What is there about this industry so peculiar that overproduction cannot be avoided regardless of the condition of the market and the needs of the consumer? Suppose we turn to the report of the Committee of Nine to the Federal Oil Conservation Board, of which the Secretary of the Interior is the Chairman. This Committee was appointed by the Board to consider a legislative program for the conservation of gas and petroleum resources.

The Committee starts out with the broad viewpoint that "true conservation does not mean the withholding from present use the Nation's natural resources." It also says "the evidence is conclusive that there is no substantial waste after the oil is once produced." It calls attention, however, to an exception to this fact and that is in times of

overproduction when excessive quantities of oil are carried in storage. Then "there is an unavoidable loss of oil at such times due to the dissipation of the more volatile elements" and there is "a decided economic loss incident to the storage." The public impression that there is a considerable loss of oil through failure at times to capture and confine it as it comes from the well is entirely erroneous. The amount of oil lost in this way is so small as to be negligible.

When it comes to the production of oil in orderly response to the economic needs of the nation, the story is quite different. The fact is that "in a very marked degree production has no relation to economic needs. The history of the oil industry has been one of recurring temporary periods of high or flush production, when the quantity of oil produced has been out of all proportion to the demand, followed by corresponding periods of low production when the supply has not been sufficient to meet the legitimate demands for the extended uses built up during the preceding period of oversupply. The resulting industrial disorganization and the forcing of oil into uses for which it is least valuable and to which it would not be put if the production were equalized and were responsive to the demands, means that there has been an economic waste. In the nature of things the extent of this waste cannot be accurately estimated, but there is no doubt that it is very extensive."

The primary reason for this economic waste, in which is included the failure to recover the full recoverable proportion of the oil content of any par-

ticular field, is the law governing the right of the owner of land to recover oil from it. Oil can be recovered by the property owner regardless of whether it is underneath his own property or is caused to flow underneath his property from the adjacent property of others by the opening of his well. There is no property in oil until it is recovered any more than there is in underground water, and it belongs to the one who first gets it. The result is a race between all the owners in a field to recover all each individual owner can. This race can only be avoided by the joint action of everyone in the field.

The seriousness of this race, however, is immeasurably increased by the part which natural gas plays in the production of crude oil. Gas dissolved in oil makes the oil more fluid. The energy stored in this gas is the chief force which causes it to move through the reservoir rock to the well, and its proper utilization results in greater oil recovery at lower cost. Any waste of this gas lessens the propulsive force which results in lesser recovery and greater cost, and the release of gas through one well affects all other wells in the same field. Each operator in a field must get his wells in oil-bearing strata with all possible speed and then keep on producing from them to capacity. Otherwise he will lose to his neighbors the advantages of the common gas content of the pool.

In this way we have two serious results of the law governing the right of an owner of land to recover oil from it and the antitrust law which prohibits co-operative agreements for the restriction of produc-

tion and the stabilization of prices in any given industry. The first is that the gas content of the field is largely dissipated and lost for the benefit of the first few wells that tapped the oil-bearing strata, thereby reducing the amount of oil which might be recovered from the whole field. The second is that once the field is opened every owner and operator must secure from his land all the oil possible at the earliest possible moment. He cannot wait for market conditions or anything else. There is no way of holding back production, and a flood of oil is produced regardless of economic demands. Hence the need for a legislative program.

One of the first suggestions to be made was a change in the law governing the right of recovery. It was thought that this law might be changed so that the owner would only be entitled to all the oil naturally in place under his land, and no more. There are not only serious constitutional objections to such a scheme but there are technical objections which make it wholly impractical. There is no way to determine with any certainty what oil comes from one man's land and what comes from his neighbor's. Such a law would create a condition of insecurity and only result in interminable litigation. This leaves only one possible solution—the uniting of all the owners in a particular field in some common plan for the development and operation of that field. No uniform plan is possible, for no two fields are alike; and the plan which might be best for one field and most equitable as between those interested in it would probably not be applicable to another field.

The industry would have engaged in these co-

operative agreements long ago had it not been for fear of the antitrust laws. A necessary feature of any cooperative plan is the control of production; and "control of production" is anathema to those of our legislators who seem to have a congenital dislike of success and whose legislative activities are largely confined to "trust-busting" and attacks on large industrial groups.

The fear of violating the antitrust laws by entering into cooperative agreements for the control of production in specific fields does not seem to be well founded, according to the members of the Committee of Nine. "It seems clear to us," they say, "that any agreement for the cooperative development and operation of a single pool, even though it involve the control or curtailment of production from that pool, is not a contract or agreement in violation of any antitrust law, either state or federal. Nevertheless, the fear exists, and has been a serious deterrent to the making of cooperative agreements. It should be removed. We therefore recommend that both Congress and the legislatures of the oil-producing states be asked to pass legislation which will unequivocally remove such agreements from the purview of laws forbidding restraints on commerce."

This is not the only recommendation of the Committee of Nine. It believes that when there is danger of overproduction in spite of these cooperative agreements, the operators should be permitted to curtail drilling and production by agreement between themselves. At the present time such agreements would be in violation of the antitrust laws of some,

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if not all, of the oil-producing states, and under some circumstances in violation of the federal laws prohibiting restraints on interstate and foreign commerce. The Committee suggests that the Federal Oil Conservation Board have governmental authority to declare when such agreements could be made and the period for which they should be effective.

A third recommendation has to do with the waste of the gas content of an oil pool. "We are agreed," says the report, "that suitable legislation to this end is the most important affirmative step to compel conservation that can be taken. Such legislation, if properly devised, will, we believe, not only prevent waste existing at the present time, but will have a decided effect in inducing agreements for the co-operative development and operation of oil fields, and such cooperative development and operation constitutes, we believe, the most important means of fully utilizing and conserving in the true sense our oil resources."

The importance of these conclusions and recommendations of the Committee of Nine is greatly enhanced by the fact that Mr. Abraham P. Myers is a member of the Committee. Mr. Myers happens to be a member of the Federal Trade Commission also. If he represents the point of view of his fellow members of the Trade Commission, then the industry has taken its biggest hurdle in its effort to acquire a sensible program of oil conservation which will stabilize the industry and avoid the ruinous periods of overproduction. If he does not represent the viewpoint of his fellow commissioners, then he is to be congratulated on his willingness

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to serve the people of the United States regardless of their displeasure.

This Committee of Nine did not stop at conclusions and recommendations. It drafted a proposed federal statute "to promote conservation of petroleum and natural gas and to avoid waste thereof, and to encourage the establishment and maintenance of underground reserves of such minerals, and for these ends authorizes certain agreements." If by any chance Congress should enact such legislation, the oil industry would be lifted out of politics for ever and ever and allowed to proceed in an orderly manner to organize production on a sound economic basis to the best interests of everyone. Because it is a matter of grave importance I give the full text of this proposed act as follows:

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the term 'person' or 'persons' as used in this act shall include individuals, partnerships, associations and corporations interested in oil or gas deposits, as owners, lessors, lessees, royalty owners or otherwise. The term 'oil and gas pool' as used in this act shall mean that area embracing the holdings of two or more persons containing oil or gas or both that is concentrated in a single geological structure. The term 'cooperative development and operation' shall mean and include any agreed plan for the development and operation of a pool, as above defined, in

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such manner as to avoid wasteful methods of development and production, and cause as efficient and complete a recovery as practicable.

"Sec. 2. No agreement by two or more persons for the cooperative development and operation of an oil and gas pool shall be deemed in violation of any of the Acts of Congress forbidding monopolies or agreements in restraint of interstate commerce.

"Sec. 3. Agreements between oil producers for the curtailment of the drilling of oil wells and of the production of oil during periods of overproduction, as such periods are determined and declared as hereinafter provided, shall, when made in compliance with the conditions hereinafter provided, be deemed not in violation of any Act of Congress forbidding monopolies or agreements in restraint of interstate or foreign commerce. No period of overproduction shall be deemed to exist, for the purposes of this act, unless and until the same has been publicly declared to exist by the Federal Oil Conservation Board, consisting of the Secretary of the Interior, the Secretary of War, the Secretary of the Navy, and the Secretary of Commerce, nor shall any such period be deemed to continue after said Board has publicly declared the same to be ended. Said Board is authorized to investigate and ascertain from time to time whether a state of overproduction of oil exists within the United States, and the district or districts wherein it

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exists, and if in its judgment such state does exist, to declare publicly, in a manner to be prescribed by the Board, the existence of such state and the district or districts wherein it exists, and in similar fashion to determine and declare that such state is at an end.

"Every such agreement shall comply with the following conditions:

"(a) It shall be in writing and be filed with the Federal Oil Conservation Board.

"(b) It shall by its terms expressly provide (1) that it shall not be operative until it has been filed with said Board, (2) that it shall not be operative except during a period or periods of overproduction, as the same are determined and declared by said Board, and only within the district or districts within which a state of overproduction is so declared to exist, and

"(c) That it is subject to disapproval by said Board at any time on the ground that it is not in the public interest, and upon such disapproval and notification thereof to the parties, in such manner as may be prescribed by the Board, shall at once cease to be operative.

"The Federal Oil Conservation Board is authorized to prescribe necessary and proper rules and regulations and to do any and all things necessary to carry out and accomplish the purposes of this act."

This is one of the most noteworthy offerings ever handed to a great industry by any government insti-

tution. If the trust-busters, the politicians, and the noisy advocates of government in every business under the sun can only be kept quiet or ignored and some such legislation as this enacted, we will have one of the greatest examples of conservation of natural resources that the world has ever seen. One is reminded of the story of Napoleon, who, having fled to Paris after the battle of Waterloo, stood in a palace window listening to the cheers of the people outside who called upon him to organize them into another army. "Why should they cheer me?" he cried. "What have I done for them? I found them poor, I leave them poor."

"That," in the words of Bruce Barton, "is the tragic epitaph of almost all the agitators, all the self-appointed, self-proclaiming friends of the people, from the days of the Pharaohs down to the present hour. They promise everything, but the people pay a high price for such promises. They pay in disillusionment, in blasted hopes, in high taxes, and in the evils of patent medicine economies."

If the government will only remove the threat of prosecution under the anti-trust laws, the industry can get together on effective steps for the fullest conservation of our oil supply. There is not the slightest objection to proceeding under rules and regulations laid down by the Federal Oil Conservation Board. In fact, it would be far better this way, for it removes any chance of accusation of monopoly. The oil industry at the present time is the most highly competitive industry in the world. There is no reason why it should not remain so and yet, at the same time, be permitted to carry out

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some such scheme as suggested by the Committee of Nine. In fact, it is the only way the problem of overproduction can be solved. This is something the government itself can never do and—God forbid—should never attempt.

CHAPTER XIX

A Few Facts About Taxes

THERE is probably no subject in connection with our daily lives about which the average man knows so little, and at the same time about which he does so much general complaining, as taxes. It makes little difference whether his tax bill is five dollars a year or five thousand or fifty thousand, he always feels that in some way or other some one has taken advantage of him and that he has been forced by the police power of the government to pay something for which he has received nothing in return. What he so often fails to understand is that, even though he may never pay a cent in taxes direct to his city, state or federal government, there is never a day of his life when he does not contribute something to the national tax bill.

It is these indirect taxes, the taxes which are ever present in any financial transaction whether it involve only five cents or five million dollars, that carry the bulk of the cost of government; and the ultimate consumer pays them just as surely as the owner of a piece of real estate pays a direct tax on it. In other words, American commerce and industry is nothing more or less than a vast aggregation of tax collectors working for the government and including the government's bit in every trans-

action and in every bill that is rendered or collected. Ten per cent of every light and power bill is a bill for taxes and the result is \$136,000,000 a year poured into the government till by the electric industry in addition to its property, corporation income, and other taxes. The bill for every item of food which comes into the house, for the coal in the cellar or for the oil for the oil burner as the case may be, for the use of the telephone, for clothes and for a multitude of other items—each carries its share of taxes for government.

All of these facts are, of course, well known and have been so thoroughly discussed that it would seem unnecessary to include a chapter on taxes in a book on fire and fuels. The coal, gas and oil industry all pay their city and state and federal taxes and all of them pass these taxes on to the ultimate consumer just as the light and power industry, transportation, steel or the automotive industries add their taxes to the cost of their products. However, the petroleum industry has created something which is more or less new in the way of taxation—a direct sales tax which the consumer pays at the time of his purchase, which is usually quoted as an item separate from the cost of the commodity, which varies in various states and which is used for a specific purpose rather than for the general purposes of government. This is the gasoline tax.

The gasoline tax is the result of the development of the automotive industry, the development of the fuel we call gasoline and the imperative necessity for roads of a type which will stand up under the

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tremendous automobile traffic of today. In my opinion it should seem to be the most sane, most equitable theory of taxation which has ever been proposed. The roads of today are constructed for the motor vehicle. They are used so little by the horse-drawn vehicle that it is negligible. It would therefore seem logical to say that they should be paid for by the owners of motor vehicles—the people who, in the last analysis, are the people who use them. The question therefore has been how to apply such a tax and how to make it equitable.

The first thought, naturally, is a tax on the motor vehicle itself. This would be all very well if all motor vehicles were alike and all used over the same mileage each year. Then each owner would pay exactly the same tax for exactly the same use of the roads. Furthermore, in order to be exactly fair to the citizens of each state, it would be necessary for each motor-car owner to confine the use of his car to the state in which he paid his motor vehicle tax. Of course it might be possible to arrange a tax on motor vehicles on the basis of weight and horse power and thus take care of the differential caused by the difference in various types of motor vehicles (license fees are frequently fixed in this way), but this would not take care of the fact that one motor vehicle is used only 5,000 miles a year while another may be used for 20,000 miles, or that one owner never crosses the border of his home state while another may travel in a dozen states each year.

So the gasoline sales tax was adopted first by one state and then by another until today no less than

forty-six states and the District of Columbia are imposing such a tax. The proceeds of this tax in almost every instance go into the construction of the roads used by the people who pay it. Furthermore, every gasoline taxpayer contributes to the roads in direct ratio to the amount he uses them. The owner of a light car who drives only a few thousand miles uses much less gasoline than the owner of a heavy car who travels two or three times as many miles. The amount of tax depends on the amount of gasoline used and the amount of gasoline used determines the wear and tear on the roads caused by the individual taxpayer. He pays for what he gets; no more, no less.

Furthermore, the resident of one state pays for his use of the roads of another state. If he travels in a state other than his own to any appreciable extent he will have to buy gasoline in that state and thereby contribute to the cost and the upkeep of the roads he is using. His position is exactly the same as that of the resident of the state in which he is traveling; he is paying in exactly the same way for the use of the roads, which is as it should be. It would therefore seem that the theory of the gasoline tax is sound if we are to call upon the motorists to pay for the building and maintaining of the roads they use.

But like so many other "perfect" theories of taxation, there seem to be several flaws in the practical application of the gasoline tax. In the beginning it was called a popular tax, and there is some evidence that, in spite of the fact that taxation is one

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of the most unpopular functions of government, it might have remained as nearly a popular tax as any tax could be if those who guide our tax destinies had not been carried away with the ease with which a tax of this kind can be imposed and collected. But the gasoline tax burden has been growing heavier and heavier until today, averaging the whole country, at least one-fifth of the motorist's gasoline expenditure goes for state taxes. There is considerable evidence that the people are becoming conscious of the burden represented by this tax.

The average tax on gasoline was approximately one cent a gallon until 1923. In 1927 there were four states with a five-cent tax, one state with a four-and-one-half-cent tax, seven states with a four-cent tax, two with a three-and-one-half-cent tax, sixteen with a three-cent tax, fourteen with a two-cent tax and not a single one-cent tax in the United States. For this tax the oil industry is tax collector and tax guarantor. In the beginning the industry only grumbled over being required to collect taxes without compensation, but as the average gasoline tax continues to mount it is beginning to become a little alarmed. More than one big producer and refiner is of the opinion that the period of complacency on the part of both the industry and taxpayer is drawing to a close. The gasoline tax is losing something of its popularity due to the excesses to which the tax fixers have gone.

In many instances the epidemic of the gasoline tax is not confined to the state; it is spreading to political subdivisions of the state. In some instances,

cities are levying as much as four cents a gallon, and in many instances two and three cents a gallon in addition to the state tax. Gasoline is also subjected to inspection fees and to an *ad valorem* tax. Pumps are licensed, service stations are licensed, and measuring devices are subject to an inspection fee. In other words, our theory that a gasoline tax shall be levied for the purpose of building and maintaining roads for the motorists and shall be paid by the motorist by means of some equitable scheme is slipping—gasoline because it is cheap is being made to carry a tax burden for all sorts of purposes out of all proportion to its cost.

So we seem to have a theory of taxation which, if properly worked, would be equitable in every detail but which is not working out so that it is equitable. What is the answer? If it is right in theory surely there must be some practical way of applying the theory. If the individual motorist should pay for road improvements in direct ratio to the amount of use he gets out of those roads, and if the easiest way of collecting his debt from him is by means of a gasoline tax, then how can the equitable features of such a tax be maintained?

The first answer is a uniform gasoline tax law. This tax might be a tax on imports carrying a reasonable allowance for shrinkage which would lessen the burden on the industry as well as on the state and simplify the levy and collection of the tax. In the second place, it would perhaps be well to place this tax on the distributor and require him to register as such. In the third place, every state gasoline tax ought to be in lieu of any excise by any

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political subdivision of the state. Municipalities should not be allowed to add a four-cent to a state's five-cent burden upon a gallon of gasoline. Finally, the public ought to be thoroughly informed about the tax burden they are bearing. If it isn't, the average citizen may wake up some morning and throw the whole good-roads' program out of gear.

In 1924 the total revenue received throughout the United States from the gasoline tax was \$79,734,-490. In 1925 this increased to \$146,028,940, in 1926 to \$187,603,231 and in 1927 to \$258,838,-813. The revenues from state gasoline taxes according to Thomas H. MacDonald, Chief of the United States Bureau of Public Roads, "have been a very vital factor in making the trails of the early settlers great arteries of traffic for the pleasure-bound motorist. All fourteen states traversed by Route 40 [a transcontinental highway 3,205 miles long] levy gasoline taxes. . . . The gasoline tax is now one of the most important sources of highway revenue, its yield representing nearly one-fourth of the total of all funds available for road purposes." It would therefore seem that any trend in the manner of fixing and imposing this tax which makes it unpopular and which may bring about such public resistance as to upset the whole scheme is a matter for grave concern.

If the gasoline tax only pays approximately one-fourth of the bill for our highway program, where does the rest come from? The following figures show taxes paid by motorists, auto and oil companies, which more than meet the whole highway cost of over a billion dollars annually:

P R O M E T H E U S , U . S . A .

What Motorists, Auto and Oil Companies Pay—Annual Revenue

State gasoline taxes.....	\$259,000,000
Vehicle licenses and drivers' licenses.....	301,000,000
Property taxes on automobiles.....	125,000,000
Federal excise tax on autos, parts and accessories.	140,000,000
Wheelage taxes, cities and counties, and motorists' fines	50,000,000
Production, corporation and income taxes of auto and oil industries.....	345,000,000
Total	\$1,220,000,000

As the taxes paid by the oil companies and the automobile manufacturers are reflected in the price of their products and paid by the ultimate consumer as indirect taxes, and as the gasoline tax is more in line with a direct tax paid at the time of purchase, it can be said without much fear of contradiction that the motorist is paying for the good roads on which he travels with some additional amount for good measure. At the same time, it must not be forgotten that it is not only the motorist who is benefited by good roads. These roads are of inestimable benefit to the farmer, extending his markets for his product and at the same time bringing to him the possibilities of electric lights and all the labor-saving devices operated by electricity. They have broadened the educational facilities of rural sections by making possible the consolidated school in the place of the old-fashioned one-room school-house at the crossroads. An improved highway increases the value of property all along its route. It takes the city dweller into the country and the farmer and his family into the city. It has altered the whole transportation scheme of the United

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States and in the last analysis we have a modern fuel—petroleum—to thank for this tremendous stride in our national progress. Just because that fuel is cheap we should not permit the program for its taxation to become so extended that the public becomes aroused to such an extent that it will tip the whole thing over.

CHAPTER XX

Research

IN 1927 Ernest Calkins, writing in the *Atlantic Monthly*, said: "Business today offers something of the glory that in the past was given to the crusader, the soldier, the courtier, the explorer, and sometimes the martyr—the test of wits, of brain, of quick thinking, the spirit of adventure, and especially the glory of personal achievement."

This is true, and the reason is that the day has gone forever when any industry worthy of the name can stand still. It must either go forward improving the quality of its product, increasing production and lowering costs, finding new markets and strengthening the old, eliminating waste and extending the sphere of usefulness of its commodity, or it will surely stagnate, begin to slip backward, and eventually die. And to do these things it must have crusaders, soldiers, explorers, and martyrs—men and women of wit, of brain, of quick thinking, with the spirit of adventure and the desire to achieve. Science is making a new world. As Mr. Hugh Farrell says, "the application of science to industry is strewing the path of progress with the débris of once flourishing enterprises." New industries with new managers and new owners are constantly taking the place of the old.

It is the dominating spirit of our times to seize a

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new thing, pay for it, and use it because it is better. This is not profligacy—it is proof of our prosperity and advanced standards of living. Without this spirit and faith in the future we would have an atrophy in our production inventive genius, and industrial progress. Because of it no industry which does not command the services of science and the resources of research laboratories can be secure. The alertness of managers in the matter of the progress of science is one of the most important factors in the continued success of any industry.

This does not mean that science is some terrible ogre that is gobbling up industries. It does not destroy; it builds, purifies, simplifies, and creates. It makes two dollars grow where one grew before. It may render the machinery and materials used in the manufacture of certain products obsolete and valueless, but it usually improves or cheapens the cost of the product itself. Economics, through price, may create the market, but science, through research, improves methods of production and manufacture, thereby lowering costs and showing economics the road to new markets.

And so the heart of any great industry must be found in its research laboratory. If that industry is to protect its investors and the integrity of its securities it must not only keep pace with science; it must keep about two jumps ahead of it. At any moment, some chemist, physicist, or engineer may hit on something that will seriously affect any one of a number of industries. The major industries appreciate this and have adopted the policy of harnessing scientists and placing upon them the respon-

sibility of keeping industry in step with the parade of progress.

Before the war we were largely dependent on Chile for nitrates—so important and necessary in the manufacture of fertilizer and munitions of war. Science now plucks it out of the air, fixes it, and today we have, in our own country, an unlimited source of supply of fixed nitrogen. Who knows how soon the day will come when science will find a way to pluck something out of the air or the waters of the sea which will cause all fuel *per se*, as we know it today, to pass quickly into the history of forgotten industries. Does it sound any more foolish to say that the day may come when science will pull light, heat, and power out of the air and distribute them by wireless to the factory and the home than it did fifty years ago to say that the time would come when man would fly in a heavier than air machine or talk across the seas without wires? And if that day does come what will happen to our light and power, gas, coal, and oil industries? If they did not keep pace with science (which, fortunately, they are doing) they would find themselves with constantly retreating markets, which is putting it most conservatively.

But our fuel-supplying agencies have not been slow to recognize the value of scientific research. Back in 1914 the great public-utility companies paid something less than \$2 a ton for coal and were reasonably satisfied. When the price advanced to two and three times the 1914 price they began to put science to work, and by the end of 1924 some of them were using less than a third of the

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tonnage they used in 1914 and were paying less for the coal they consumed, notwithstanding that the tonnage rate was more than double the 1914 rate. It has only been a comparatively few years since it took more than three pounds of coal to generate one kilowatt-hour of electricity, and today some of the more modern plants are generating a kilowatt-hour with less than one pound of coal. All of this is the result of applied science.

Incidentally, as we have seen in a previous chapter, this has, in some sections of the United States, lessened the importance of water power and the hydro-electric plant as a competitor of steam in the generation of electricity. It is well that this is so, for if all of the water powers in the United States were fully developed they could only supply a fraction of our light and power needs. With the improvement of the art of generating by steam, with the use of oil or coal as fuel, the cost of manufacture of electricity is becoming of less importance and the electrical engineer is being given more and more time to work on the problems of cost of distribution. The light and power companies which have not effected economies must do so sooner or later if they wish to survive, and the companies who have effected them will have to go on developing new economies by the aid of science for the same reason.

The development of automatic heating by the gas- and oil-burner industries has doomed coal as a direct fuel for the heating of homes and buildings. This does not mean that the coal industry is

doomed; in fact, it is quite the best thing that could happen to it. Science has discovered so many better and more economical ways for using coal than as a direct fuel that nothing could be more wasteful than its use in the latter way. The coal formerly burned in the home furnace can be used as a raw material for the manufacture of innumerable valuable products, as we have seen in an earlier chapter. Used in the manufacture of gas, it gives us as by-products coke, ammonium sulphate, benzol, and tar. Its use in great central generating stations means more and more cheap power for industry and agriculture. In fact, it might be safely said that applied science, by destroying the use of coal as raw fuel in the home, has made two dollars grow for the coal industry where only one grew before.

When electric lighting from a central generating station became an assured fact it was thought, for a time, that the manufactured-gas industry was doomed. Yet today it is one of the great major industries of the United States even though its use for artificial light is archaic. Applied science turned the trick by showing the gas industry how to develop new markets to an extent never dreamed of when gas was first introduced for lighting purposes. The public today thinks of gas almost exclusively in terms of cooking, although it has many uses in industry and gas companies are rapidly extending their markets for home heating. With the aid of science and the research laboratory the gas industry is rapidly reducing the cost of production, which, of course, means an extension of markets.

In fact, it is the competitor of fuel oil today for the production of automatic heat.

It is in the history of the petroleum industry, however, where we find the most interesting relation between applied science and a fuel industry and where we also find that the results of the work of the scientist have a distinct bearing on the economic phase of the industry—that is, in the stabilization of prices. This has best been described in a statement made by Mr. Walter Teagle, president of the Standard Oil Company of New Jersey, to the Federal Oil Conservation Board. He said:

“Since its inception the petroleum industry has passed through three closely interrelated phases, in the first two of which the value of a barrel of crude has been determined practically by the price the public paid for a single product. In the early history crude derived its value from its kerosene content. . . . At the time when gas and electricity began to displace kerosene as an illuminant the advent of the motor-car inaugurated the second phase of the industry and kerosene lost its place to gasoline as the product determining the value of a barrel of crude. . . . The price differential between gasoline and the fuel-oil value of fuel and high sulphur crudes was the incentive for the further development of cracking processes which have been perfected within the past two or three years, and the industry is thus for the first time in a position to produce gasoline from them. Every grade of crude oil produced is now a potential source of gasoline. Thus the third phase of the cycle of change

has been reached. . . . Gasoline produced from the initial distillation is, therefore, no longer the controlling factor in determining the value of a barrel of crude. The price of the by-product—fuel oil—has ceased to be incidental and has become a real factor in the determination of this value.”

Commenting on this statement and on the fact that a single product—first kerosene, then gasoline, and now fuel oil because of its inherent potentialities for the production of gasoline—has controlled the price of all the products of a barrel of crude, one might suggest that from the point of view of sound economics and stable merchandizing this is not an ideal state of affairs. The price of a barrel of crude should be governed entirely by the sum total value of each and every product that goes to make up that barrel. In such a perfect state of affairs each product of the petroleum barrel would fill a genuine human need for every property of that product and that product only. There would be no waste. Gasoline would fill to the full the human need for it through motor-cars and other motor uses. The other products of the barrel would have a similar market representing a continuous demand. The intrinsic price of each product would be automatically determined by the universality of this demand and by supply.

It is not difficult to believe that the advent of the domestic oil-burner is a step—and a very large step—in the direction of this stabilization of the price of a barrel of crude. The domestic and commercial oil-burners use, for the most part, gas oils and distillates, which have been in the past, so far as price-

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determining mining factors are concerned, secondary products. As the sale and use of oil-burners mount, there is being established a dependable market that tends to allow these oils to assume an importance as price-determining factors. The larger oil-burners of the type used in industrial installations use fuel oil as fuel, and to the extent that their use increases, fuel oil will assume the same importance in its own right.

We know that there is today a demand for oil heat in domestic and commercial buildings. We know that this demand is increasing rapidly. These installations represent a large and increasing market for gas, distillate, and fuel oil. These oils, thus employed, are being utilized in the spirit of true conservation, for they are being used to their greatest intrinsic value; they are contributing to human welfare to their fullest extent and performing a task that no other product can do with equal economical success. As the demands for these oils for use in oil-heating installations increase, they will assume more and more importance as factors determining the price of crude. And as they approach this position of importance it will be increasingly difficult for a single product of the barrel of crude to determine the price of the whole barrel—tending toward that time, that may or may never be reached, when all of the products will have assumed their own places in the sun as not only influential, but vital forces in determining the prices of all petroleum products. Every step toward that end is a step toward perfect stabilization.

Here we have applied science, by developing and perfecting devices for the use of oil fuel, stepping over into the field of economics and playing its part in the stabilization of the price of the product of a great industry. Furthermore, it may be due largely to the development of oil heating that we are to be assured of little or no increase in the price of gasoline.

Of course the oil industry is subject to the hazard of a great revolutionary change. The chemist can and may find—if he has not already found it—a substitute for gasoline that would turn the industry upside down. When that time comes, if it does come, science will have found the answer to the problem created for the industry, for the leaders appreciate only too well what it would mean and have already employed science. If gasoline as a motor fuel should pass from the picture, cracking processes would stop and the fuel-oil content in the products of a barrel of crude would be greatly increased. It would mean little more than readjustment of manufacturing processes.

In any event, the future of the oil industry, or of the coal industry, or of the gas industry belongs to those who know how to make the best use of the present. It belongs to those who, with the assistance of scientific research, are determined to eliminate waste, minimize lost motion, make the material yield every ounce of product that it can yield in the shortest space of time. "We are at the beginning of a new era," says Mr. Farrell. "New principles, new processes, and new products

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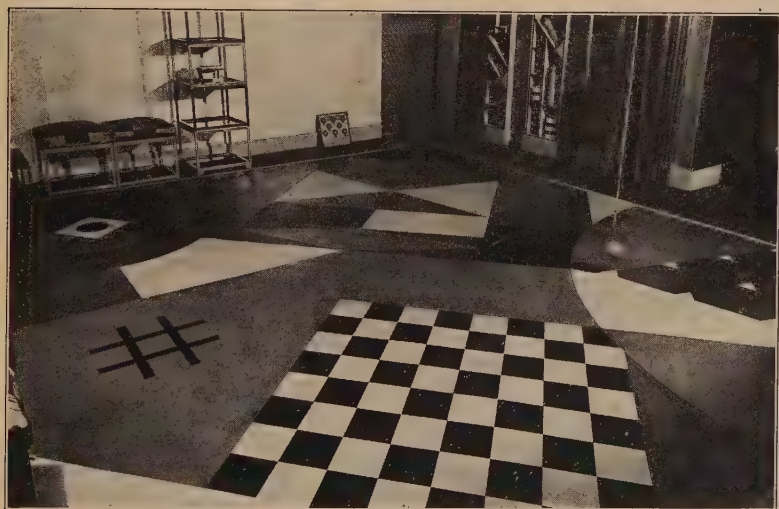
are appearing on every side, but we are only at the beginning." This is so obvious that its statement borders on the bromidic. It means, however, that the industry which is not alert to the advances of scientific research can hardly hope to survive.

CHAPTER XXI

Summary and Conclusion

NO DOUBT everyone will admit that Prometheus was right when he decided that the easiest way to make man superior to all other animals would be to make him a present of fire. Fire has been the greatest gift to mankind, and without it we would have progressed but little beyond the Neanderthaler stage of human existence. It enabled man to migrate from warmer to colder climates. It furnished him with warmth, artificial light, and his first cooked food. In fact, it was only after he discovered that fire was something to be used that the first germ of civilization was sown.

The vicissitudes and constant dangers of living in the days of the early man made existence a ceaseless struggle against elements and other animals. Man foraged for food and combined his efforts with those of his neighbors when it was to their mutual advantage. Family life, such as we know it today, was more of a huddle for warmth or protection than a social gathering; that began when man adapted fire for his use. It was a protection against the elements, a weapon against the animals, the magnet that drew people together. Language, it is not impossible to conceive, could be dated to the guttural utterings of a nomadic group tending



Courtesy of The Delineator

INTERIOR DECORATION GOES INTO THE BASEMENT WITH AUTO-
MATIC HEAT

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a fire on a cold night. Common interests were discussed around the hearth. The fire belonged to all of them and it served all of them. The faint beginnings of society were conceived in the warmth and glow of the first public utility of the human race.

In other words, with the community fire came the first glimmer of a state. It transformed man from an individualist into an integral part of a community and taught him the first lessons in coöperation. It established a permanent home with some kind of organized family life. As his intelligence expanded he came to depend more and more on fire as a device with which to fabricate the things demanded by his constantly growing needs.

However, it was only when man began to become dissatisfied with his methods of utilizing fire that his real progress began. His ennui and restless dissatisfaction with life in general has, from time immemorial, been reflected in all of his activities as it should be, for this restless groping after something better is the basis of all progress.

There is no way of knowing how many centuries elapsed before man became dissatisfied with his open bonfire fed with wood; we cannot calculate the number of years before he questioned its efficiency and said to himself, in effect, "This is not so good." Eventually, however, he must have inclosed it in some kind of a fireplace, and this step was followed, perhaps centuries later, with a crude chimney. We also know that sooner or later he must have become tired of the presence of fire as such, and in the Roman hypocaust we have the first

evidence of an attempt to remove it from physical proximity. The Romans—the first people of whom there is any record of an attempt at central heating in the basement—were a meticulous people. In their advanced civilization they took many steps to eliminate the grossness of living as such and to push out of sight the ugly machinery of life.

The hypocaust, crude as it was, satisfied for a while. As we have seen, it was nothing more than a great fire built in a vault in the cellar and tended by slaves. When the mistress of the house wanted warmth she pounded on the wall, and in a little while smoke accompanied by heat began pouring through the crevices. In time it passed and man returned to the open fireplace with wood as fuel. With the coming of coal, which made a lingering fire, he became enthusiastic, saw new possibilities, and, after untold centuries, the first real improvements in the utilization of fire began. He learned to inclose it in an iron box, or stove, which he constantly improved with draughts and what not until, like his ancestors, tired of the physical presence of fire, he discovered he could put it in the cellar out of sight.

From this time on progress in the art of heating was rapid. Following the warm-air furnace came hot-water and steam plants using coal for fuel, and finally automatic heat with oil or gas. Man had found, at last, the perfect servant by means of which he put away, out of sight, a part of the ugly machinery of life. He now can have artificial warmth without being conscious of the device which furnishes it. The progress from the old Franklin

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stove to automatic heat is greater than the total progress during the thousands and thousands of years which elapsed between the wood bonfire and the Franklin stove. In point of years it is a mirror reflecting the tortoise-like journey of man from the dawn of history until the beginning of the present age of machine slaves.

It is only yesterday that our mothers and grandmothers were toiling with the coal range in the kitchen, and the astonishing thing about it is that it took man so long to question its perfection and to say to himself, "There must be something better." The housewife of those days had to be a competent heating engineer if she was to be a good cook. Her knowledge of how to build and keep the fire played quite as important a part in the production of the good things which came on the table as her knowledge of how to prepare and mix the ingredients. Water had to be heated on this range, and the Saturday-night bath was taken in tin or wooden tubs in the kitchen beside it. The only artificial light came from candles or, at best, the kerosene lamp. Refrigeration, electric lights, running water, the gas range, and a host of other conveniences which are commonplace today were unknown.

Then came the gas company with its gas ranges to relieve the housewife from untold drudgery. Kitchens are thought of today in terms of gas ranges. Here was a device by means of which heat for cooking could be had at a moment's notice just when it was wanted, and turned off completely the moment it was no longer needed. No longer was

it necessary for the housewife to be a heating engineer—the gas company had relieved her of that obligation. No longer did the kitchen resemble a Turkish bath in summer. This was followed by the gas hot-water heater to take the place of the old coal-range boiler, and coal in the kitchen as direct fuel was gone forever.

In the meantime man was busy with the creation of devices to take the place of the coal range in those districts where gas was not obtainable. Oil ranges and portable oil stoves for heating began to appear on the market, and their manufacture soon became a great industry. Even today this is a thriving industry and literally hundreds of thousands of oil ranges and portable oil heaters are manufactured and sold all over the world every year.

Then man began to turn his attention to house heating. With the constant improvement in coal-burning central plants in the cellar it seemed as though little more could be done. But he resented having thrust upon him continually the machinery by means of which he kept warm—the drudgery of the coal furnace made him say once more to himself, “There must be something” even better, and turned his thoughts to something which would relieve him of it. Experiments in oil-burning devices had been going on for a long time and the gas companies were searching for a type of burner which would enable them to heat the home at a cost which would be within range of the man of moderate means.

The result has been automatic heat—the perfect

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servant. The coal-burning furnace is passing and its place is being taken by an oil- and gas-burning device controlled automatically by a thermostat. Yet all of this has happened since yesterday and a very short yesterday at that. After tens of thousands of years of struggling with coal and wood fires, man, because of his dissatisfaction, has at last produced a method of utilizing fire which requires absolutely no effort on his part. Drudgery in connection with the use of fire is a thing of the past.

What of the future? No one knows and no one can predict. No doubt the time is coming, and coming rapidly, when the same unit in the cellar will warm the house automatically in the winter and cool it automatically in the summer. A combination heating and refrigeration plant is quite within the range of possibilities. The gift of Prometheus has in turn given man every comfort he has today, and will continue to give added comforts as long as man is dissatisfied with things as they are and is continually demanding something which is better.

THE END



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